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Technologies to Enhance Observation, Documentation, and Training for
Driving Under the Influence of Drugs Enforcement

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Criminal Justice Testing and Evaluation Consortium
A Program of the National Institute of Justice

Criminal Justice Testing and Evaluation Consortium

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The products detailed in this landscape study are intended to be a good-faith overview but not an exhaustive list of commercially available products and products approaching market readiness. The inclusion of a product or company in this report does not represent NIJ's or CJTEC's recommendation, endorsement, or validation of product claims.

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EXECUTIVE SUMMARY

Technologies to Enhance Observation, Documentation, and Training for Driving Under the Influence of Drugs Enforcement

This report offers an overview of the technology landscape for tools to advance justice in law enforcement investigation of driving under the influence of drugs (DUID) cases. The report leverages interviews with law enforcement, prosecutors, and product developers. Readers are provided with an overview of emerging technologies that may improve consistency for officers in field observation, documentation, and testimony associated with DUID cases. Products and services that help officers more consistently observe and document individuals who may be DUID may address some of the challenges and complexities often associated with these cases. The intended audience includes law enforcement leaders, technical specialists within law enforcement agencies, prosecutors, policymakers, and product developers who are considering the DUID issue and how technology might help (or not). Additionally, this report can serve as a tool for legal professionals to better understand some of the technical and procedural aspects that are specific to DUID cases.

This report is organized to consider the technologies that are driving digital transformation globally: computing, connectivity, and artificial intelligence (AI). It focuses on officers' need to consistently observe, assess, and document situations involving individuals suspected of DUID. This report augments a related landscape study on physical and cognitive screening products to assess impairment and screening products to determine the presence of drugs in oral fluid, breath, or sweat.[1] Both documents collectively provide law enforcement agencies with emerging and currently available products and services that have potential applications for drug-related impaired driving cases. This report provides a higher-level technology-based perspective to consider how law enforcement might benefit from advances in hardware and software for DUID investigations. These advances may enable improved real-time communication and immersive learning.

Criminal Justice Testing and Evaluation Consortium (CJTEC)

CJTEC is a program of the National Institute of Justice (NIJ), which uses research-based methodologies to enhance the capabilities of law enforcement, courts, and corrections agencies. As a consortium, CJTEC leverages expertise from varied criminal justice community stakeholders to understand and test technologies and practices in a variety of NIJ's research areas.

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RTI International leads CJTEC. CJTEC leverages RTI's expertise in criminal justice, forensic science, innovation, technology application, economics, data analytics, statistics, program evaluation, public health, and information science.

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1. Shute, R., Ovington, T., & Criminal Justice Testing and Evaluation Consortium. (2020). *Landscape study of field-portable DUID screening products*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Retrieved from https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/

Thank you to the various criminal justice community stakeholders and practitioners who provided insights and expertise.

Interviews from subject matter experts and end users helped frame issues and consider solutions; additionally, these interviews ultimately informed this report in working to deliver key insights for decision-makers interested in implementing products and solutions. CJTEC sought feedback from stakeholders—including experts in law enforcement, drug recognition, and policy—to understand the potential value of these solutions and the practical implications of adoption and use.

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Increased adoption of technologies, driven by the world's "digital transformation," is lowering costs and expanding access to products and services that may help address the challenges and complexities associated with DUID cases.

In situations involving suspected DUID, law enforcement must follow a set of state law and agency policies and procedures that establish the legal justification for law enforcement to initially stop a vehicle, assess whether an individual is potentially impaired, and investigate further to determine if the driver may be under the influence of drugs.[2] Historically, law enforcement has developed skills to assess potential drug impairment through the completion of specialized training programs: standardized field sobriety tests (SFSTs), Advanced Roadside Impaired Driving Enforcement (ARIDE), and drug recognition expert (DRE) programs. However, as the prevalence and complexity of DUID incidents grow, so too does the demand for the time and resources on local law enforcement agencies and individual officers, who may find it challenging to take several hours or more than 1 day off to attend these DUID training programs.[3] Investigations of DUID are shrouded in complexity and constrained by limited resources; thus, many officers face challenges in gathering, investigating, and presenting reliable and valid evidence in DUID cases.[4] The overall purpose of this report is to provide stakeholders, including funding agencies, law enforcement agencies, and product developers, with insights to foster innovative thinking that leverages emerging technologies to enhance DUID evidence-gathering processes and investigative outcomes.

Technologies on the market today in use broadly beyond criminal justice may enhance DUID investigative outcomes by augmenting officers' ability to learn, observe, assess, decide, document, arrest, test, and testify. Products such as cameras and recorders, enabled by algorithms and AI, can augment officers' eyes, ears, memory, and judgment for evidence gathering. Similarly, real-time communication technologies, such as computer-aided dispatch (CAD), exist to enhance officers' connection to support. This technology makes it possible for other officers to view a situation in real time and offer support remotely. In addition, immersive learning products and services related to virtual (VR) and augmented reality (AR) are available that can help enhance officers' situational awareness through training that builds experience and empathy. As outlined in **Figure 1**, technology can increase and sharpen officers' abilities and skills in DUID cases, from initial observation to evidence gathering to testimony in court; however, some technologies, products, and services still have barriers to adoption.

This report builds forward from NIJ's Criminal Justice Requirements and Resources Consortium meeting (and subsequent report), facilitated by RTI and the RAND Corporation, toward technology-based solutions for DUID investigations.[4] This report aims to augment the preceding CJTEC landscape study of field-portable DUID screening products with an overview of emerging technologies, products, and services in the DUID process both preceding and after the "arrest and test" stage.[5]

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2. These situations may require officer assessment of illegal drug use, possession, or impairment.

3. National Highway Traffic Safety Administration. (2009). *Drug-impaired driving: Understanding the problem & ways to reduce it*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/811268.pdf

4. Gourdet, C. Vermeer, M., Planty, M. G., Banks, D., Woods, D., & Jackson, B. A. (2020). *Countering drug-impaired driving*. Santa Monica, CA: RAND. Retrieved from https://www.rand.org/pubs/research_reports/RRA108-2.html

5. Shute, R., Ovington, T., & Criminal Justice Testing and Evaluation Consortium. (2020). *Landscape study of field-portable DUID screening products*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Retrieved from https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/

The point of the report is to consider how emerging technologies might enhance officers' capabilities in DUID-related circumstances. The topic is complex; thus, this report has limitations. Materials identified, reviewed, and shared are not fully comprehensive. Product examples are used to highlight current technologies and products and are not exhaustive, but instead are intended as only illustrative. Technology evolution will quickly make these specific products "out of date," but the broader needs of officers and the potential for technological support will likely be relevant for some time because of the complexities and needs for further research and evaluations prior to widespread adoption by law enforcement.

Technology May Continue to Improve Officers' Abilities in DUID Situations

Officers' "Job" for DUID	Officers' "Tools" Today	Dispatch and DRE Support Today	Technology-Enabled Future
Learn	Classroom, field-based, and online training		Immersive learning using VR and AR
Observe/Sense	Eyes/ears/cameras with low-light and high-speed imaging	Via computer, phone, radio, and cameras	Real-time analysis of dash and body camera audio and video
Assess/Analyze	Experience and training	Via DRE on the roadside	Virtual and automated DRE support
Decide			
Document	Manual notes and recordings	Cameras, recorders, pen/paper	Smart voice services
Arrest and Test	Details in CJTEC's Landscape Study of Field-Portable DUID Screening Products		
Testify	Manually review notes and recordings using case management software Classroom training		Immersive training to prepare officers for credible testimony Auto preparation of case file and document routing

Figure 1: Emerging products may enhance officers' DUID observation, decisions, and documentation. This report builds on recent efforts to address the complexity of DUID investigations and draws on the opinions of existing users and experts and information about emerging technologies, products, and services.

Landscape Research Methodology

To conduct this study, CJTEC used an iterative process, including the following steps:

1. Participated in NIJ's Criminal Justice Requirements and Resources Consortium meeting on DUID and considered technology-related needs. Following the meeting, CJTEC considered the topic with NIJ and built forward with additional interviews with meeting organizers and key stakeholders.

2. Scanned extant literature:

   - Leveraged professional library services to identify key resources and consulted sources, such as National Highway Traffic Safety Administration (NHTSA) literature; SFST, ARIDE, and DRE training manuals from IACP; and other research publications. Sources are cited throughout the document as footnotes and in the Resources section.

3. Scanned market:

   - Used both secondary and primary research methods to identify technologies and products of interest. Specifically researched relevant technologies and products based on feedback from expert interviews. Considered technology and market knowledge from both the commercial and defense markets, including adjacent applications like gaming, social networks, remote monitoring, and Internet of Things–based services. The search methods may not be comprehensive and/or exhaustive. Product example are intended to be illustrative and do not indicate any endorsement from CJTEC. The market scan was augmented by interviewing experts and practitioners including law enforcement, prosecutors, as well as product developers to discuss current impairment assessment techniques with experts, including DREs and other law enforcement stakeholders. The scan provided stakeholder viewpoints and insights on the status of adoption for new products that assist in screening for impairment, documentation, observation, and training. Interviews were structured, but flexible based on subject matter expertise and the area the research team was investigating.

4. Consolidated and synthesized information:

   - Consolidated research to highlight findings for both technologies and products capable of supporting field operations and training for officers during a DUID investigation. This information was synthesized to provide key insights and supporting examples of new and emerging products related to DUID investigations today and in the future.

Because the report is not a market scan and is intended to "inform and inspire," it is not comprehensive, and may not be generalizable. The report informs about the status of DUID investigations today, as well as presents a future for the law enforcement community and product developers to consider.

Key Findings

As widely recognized by the criminal justice community, DUID cases are inherently complex and challenging across all phases of a DUID investigation: from initial officer observation to the documentation of findings and testimony in court. Global technology development trends offer opportunities for enhancing law enforcement capabilities in conducting such investigations, not only through improved capabilities in observation and documentation, but also in training officers to handle DUID cases. The global technology trends of most relevance to improving DUID investigations are generally related to what is commonly referred to as the "digital transformation" of society via device mobility, connectivity, storage, and AI.

Potential next-generation products and services that may improve DUID outcomes include:

- Immersive learning experiences via AR and VR, which can enable broader accessibility and more consistent training.
- High-speed/bandwidth cellular and wireless connectivity and communications for real-time observational capabilities and support of the officer in the field, including decision support and documentation of events.

While the opportunities for improving DUID investigations are significant and ever-increasing as the broader global technology developments continue at a rapid pace, there are a range of barriers to adoption by the law enforcement community. Because most of these digital products or services have not been developed or evaluated specifically for law enforcement or DUID, there are needs for research, development, and evaluation of these new capabilities for this target application.

Despite advancements in digital technologies, there are limited product offerings specific to law enforcement, further delaying potential improvements for DUID observation, documentation, and training.

CJTEC would like to remind decision-makers who are considering these new technologies that, for many, there is limited application and associated experience in law enforcement.[6] There are benefits and risks of being an early adopter. On the positive side, early adoption enables progress and potential gains; however, it also means dealing with new product development glitches that may be solved for later adopters. There are trade-offs when adopting new technologies. Waiting can pay off because over time the development of products, systems, and standards (even beyond criminal justice) brings improvements and makes adoption less risky. However, early adoption can accelerate improvement and associated benefits.

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6. Untested technology could potentially undermine or weaken the corresponding DUID case.

CONTEXT

DUID incidents present a growing challenge for law enforcement and other criminal justice community stakeholders. Product developers and service providers are leveraging emerging digital transformation technologies and developing innovative products and services that may assist observation (situational awareness), documentation, and training. NIJ's CJTEC produced this report to help agencies understand these emerging technologies and products that may address these key needs. This report is the second in a series related to DUID. The first report focused on emerging products to detect impairment, including physical manifestations (e.g., nystagmus) and chemical detection in oral fluid, sweat, and breath, to support officers who are conducting these assessments roadside.[7]

Figure 2: From legislation and funding to product development to enhance law enforcement's capabilities on the roadside and in court, DUID cases touch the complete justice ecosystem.

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7. Shute, R., Ovington, T., & Criminal Justice Testing and Evaluation Consortium. (2020). *Landscape study of field-portable DUID screening products*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Retrieved from https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/

Technology adoption begins with understanding the problem.

Driving while impaired is a significant, growing public safety issue in the U.S.

Driving while impaired from any drugs, whether these drugs are licit or illicit, is a criminal offense. According to the Substance Abuse and Mental Health Services Administration, 12.6 million Americans drove under the influence of illicit drugs in 2018.[8] An NHTSA roadside survey found 20% of weekend nighttime drivers tested positive for at least one potentially impairing drug in 2013–2014.[9, 10] The incidents of DUID could increase as more states decriminalize or legalize some forms of cannabis.[11] There is limited research linking drug use, driving performance, and crash risk.[12] More recently, Oregon voted to decriminalize small amounts of drugs, including heroin and cocaine, which could be a contributing factor to a future increase in drug-impaired driving incidents.[13]

Standards do not exist that establish impairment based on a certain amount of drugs in an individual's system.

Unlike with alcohol, for which, in most states, a driver is considered to be legally impaired if their blood alcohol concentration is 0.08 g/L or higher, only a few states have a "per se" statute regarding potential impairment from cannabis or other substances. Other states have adopted a "zero tolerance" policy, in which any detectable level of cannabis or other specified substances is evidence of potential impairment.[14, 15] Although the national standards that have been implemented for alcohol-impaired driving can be used to establish probable cause to arrest an individual, identify proof through testing, and document evidence for use in court, a similar standard does not exist for other types of drug-impaired driving. A further complicating factor is that because people react differently to drugs, signs of visible impairment may look different across individuals.[16, 17, 18]

DUID cases necessitate specialized training of law enforcement officers.

ARIDE and DRE are the advanced training programs that build on the impaired driving assessment skills taught in the SFST program. ARIDE and DRE offer more intensive, specialized training, which further develops officers' ability to skillfully understand and recognize the signs and symptoms of drivers who are impaired by substances other than alcohol. Trainees of the DRE program use a 12-step process (see **Figure 3**) and often conduct tests related to drug impairment post-arrest. This assessment of nonalcohol-related impairment typically occurs after alcohol-related impairment has been ruled out, due to a low or zero reading from a breath alcohol device reading or from other existing evidence that suggests potential drug-related impairment. Although DREs, the

8. Center for Behavioral Health Statistics and Quality. (2019). *Results from the 2018 National Survey on Drug Use and Health: Detailed tables*. Rockville, MD: SAMHSA. Retrieved from https://www.samhsa.gov/data/report/2018-nsduh-detailed-tables

9. NHTSA. (2015). *Results of the 2013–2014 National Roadside Survey of Alcohol and Drug Use by Drivers*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812118-roadside_survey_2014.pdf

10. Testing positive does not necessarily indicate impairment.

11. NCSL. (n.d.). *Deep dive: Marijuana*. Retrieved from https://www.ncsl.org/bookstore/state-legislatures-magazine/marijuana-deep-dive.aspx

12. Berning, A., Smither, D. (2014). Understanding the Limitations of Drug Test Information, Reporting, and Testing Practices in Fatal Crashes. *NHTSA's Office of Behavioral Safety Research*. Retrieved from https://rosap.ntl.bts.gov/view/dot/40777

13. Loew, T., & Barredam V. (2020). Oregon becomes first state to decriminalize small amounts of drugs, including heroin. *USA Today*. Retrieved from https://www.usatoday.com/story/news/politics/elections/2020/11/03/oregon-decriminalizes-small-amounts-drugs-including-heroin/6156552002/

14. Governors Highway Safety Association. (n.d.) *Drug impaired driving*. Retrieved from https://www.ghsa.org/state-laws/issues/drug%20impaired%20driving

15. Five states have per se laws in effect for one or more drugs. Sixteen states have zero tolerance laws in effect for one or more drugs. Governors Highway Safety Association. (2020). *Drug-impaired driving*. Retrieved from https://www.ghsa.org/state-laws/issues/drug%20impaired%20driving; Per se laws beyond alcohol do not yet have the necessary scientific basis to correlate drug level and driving behavior.

16. Lensch, T., Sloan, K., Ausmus, J., Pearson, J. L., Clements-Noelle, K., Goodman, S., & Hammond, D. (2020). Cannabis use and driving under the influence: Behaviors and attitudes by state-level legal sale of recreational cannabis. *Preventive Medicine*, 141, 106320. https://doi.org/10.1016/j.ypmed.2020.106320

17. Hartman, R. L., & Huestis, M. A. (2013). Cannabis effects on driving skills, *Clinical Chemistry*, 59(3), 478–492. https://doi.org/10.1373/clinchem.2012.194381

18. Beyond individual reactions to specific drugs, there are hundreds of drugs with vastly different effects on the body. Poly-drug use may further complicate DUID investigations.

most highly trained officers in the area of drug-related impairment, and ARIDE-trained officers can play an important role in gathering evidence to support a DUID case, these highly skilled officers are limited in number. At the end of 2019, there were only 9,878 DREs in the United States, making up only 1% of total law enforcement officials across state, city, sheriff, and other law enforcement agencies.[19] In addition, many DREs are law enforcement officers seeking advancement and therefore tend to move to higher ranks in the agency, creating turnover and the need to train replacements, but also building advocacy for advanced training. During the COVID-19 pandemic, the number of certified DREs has dropped by as much as 25% because of the inability to certify/recertify individuals.[20] To maintain this credential, DREs must successfully complete recertification requirements every 2 years.

Technology May Broaden the Skillful Recognition and Testing Needed for DUID Cases

DUID Investigations Today		Potential Future
Many officers are trained to recognize impaired drivers and to use Standardized Field Sobriety Testing (SFST) as evidence. Some officers may also have Advanced Roadside Impaired Driving Enforcement (ARIDE) training. When available, officers on the roadside may further benefit from the specialized support of a Drug Recognition Expert (DRE) after arrest. The DRE uses the 12-Step protocol (at right) to examine a DUID suspect. "The process is systematic because it is based on a complete set of observable signs and symptoms that are known to be reliable indicators of drug impairment. The DRE evaluation is standardized because it is conducted the same way, by every DRE, for every suspect whenever possible."[21] The consistency of DRE training and methods is recognized to improve outcomes for DUID adjudication, yet DRE officers are not always available.[22]	**12-Step Drug Recognition Expert (DRE) Protocol** 1 Breath Alcohol Test 2 Interview of the Arresting Officer 3 Preliminary Examination and 1st Pulse 4 Eye Examinations 5 Divided Attention Tests 6 Vital Signs and 2nd Pulse 7 Dark Room Examination 8 Check for Muscle Tone 9 Check for Injection Sites and 3rd Pulse 10 Interview, Statements, and Observations of Subject 11 Opinion of Evaluator 12 Toxicological Examinations	Next generation technology to support the officer in the field may enhance observation, communication, decisions, and documentation for all cases, including DUID. This may improve greater consistency in DUID investigations. Advancements in digital technologies are driving forward communication, data capture and analysis, and training tools that can be leveraged by law enforcement to enhance DUID outcomes. As these products and services emerge and are adopted there is the potential for broader and more consistent training, communication, evidence gathering, and testimony. New training technology can streamline training for officers by lowering costs of training, improving teaching materials and learning outcomes, and enabling scaling without the costs associated with training more trainers.

Figure 3: DUID investigations benefit from officers who use systematic approaches based on training, like the DRE 12-step process; there is the potential to augment officers' capabilities with technology-based solutions in the near future.

19. IACP. (2018). *IACP Drug Evaluation and Classification Program: 2019 annual report*. Retrieved from https://www.theiacp.org/sites/default/files/2020-04/2019%20DECP%20Annual%20Report.pdf

20. From interview with Kyle Clark (IACP DRE PM).

21. IACP. (n.d.) *12 Step Process*. Retrieved from https://www.theiacp.org/12-step-process

22. Gourdet, C. Vermeer, M., Planty, M. G., Banks, D., Woods, D., & Jackson, B. A. (2020). *Countering drug-impaired driving*. Santa Monica, CA: RAND. Retrieved from https://www.rand.org/pubs/research_reports/RRA108-2.html

DUID cases are complex, and it is critical law enforcement officers consistently follow processes and procedures with accurate documentation for fair adjudication.

DUID cases are difficult to investigate and successfully prosecute because there is no established link between a specific quantity or level of a drug in an individual's system and actual impairment. The investigation and prosecution of a drug-impaired driving case is more complex than the investigation and prosecution of an alcohol-related impaired driving case. Officers are faced with the difficult task of establishing that an individual is impaired and that the impairment is due to using a drug. Law enforcement officers play a key role in DUID investigations and thus have many "jobs to be done"[23] throughout the process of observing a potential offense through fair adjudication of a case. As illustrated in **Figure 4**, officers need to recognize patterns of DUID; make real-time decisions about whether to make contact with the suspect; and, if they do, consider and document potential impairment while interacting with the driver. Consistent practices for interacting with suspects and accurately documenting the interaction are critical to fair adjudication and to the ability of officers' evidence and in-court testimony to help contribute to a successful DUID prosecution. Pre-arrest screening, and confirmatory testing, for the presence of drugs in an individual's oral fluid, breath, or sweat is offered in the CJTEC companion report.
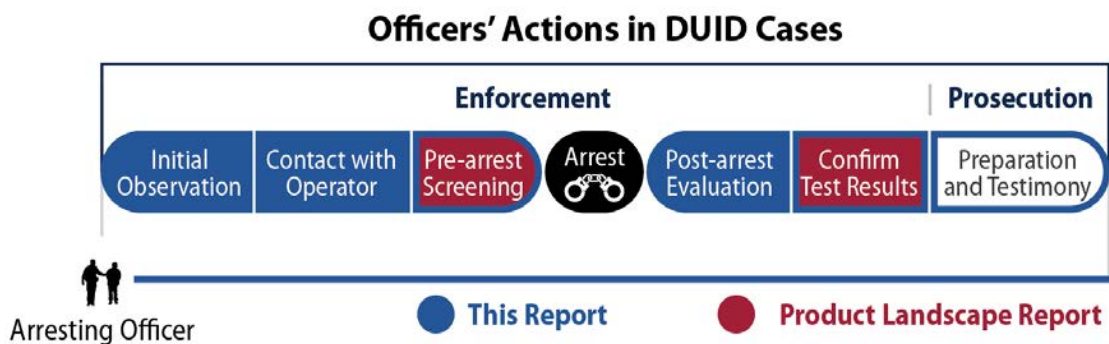

Figure 4: Officers' tasks in DUID cases can be supported by technology; the initial observation, contact, and evaluation of suspects is the focus of this report (tasks in blue); pre-arrest screening and confirmatory testing are addressed in a companion report (tasks in red).[24]

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23. Christensen, C. M., Hall, T., Dillon, K., & Duncan, D. S. (2016). *Know your customers: Jobs to be done*. Retrieved from https://hbr.org/2016/09/know-your-customers-jobs-to-be-done

24. Documentation technologies and immersive learning could be applied to testimony; however, prosecution is not within the scope of this report. Similarly, electronic warrants (e-Warrants) are technology enabled and impact DUID outcomes. However, because prosecution is not within the scope of this report, we made the conscious decision to omit any discussion of e-Warrants hereafter.

Emerging and existing technology-enabled products and services support officers in observing, assessing, and documenting interactions with DUID suspects to enhance DUID outcomes.[25]

The gathering of evidence for investigative purposes can have two different uses in DUID cases. First, for purely investigative purposes, evidence is gathered to help officers understand the context of the incident and establish probable cause to arrest the person, take a biological sample, and take other actions (such as calling in a DRE). Second, evidence is gathered to use as substantive evidence that is admissible in a DUID case to help prove the DUID charges.[26] Law enforcement officers' tasks related to the DUID investigation process include the following:

- **Observation and Assessment (to make a decision):** The officers must first observe signs of poor driving performance, whether from distraction, alcohol, or drugs. Officers rely on assessing driving impairment (and possible driving while intoxicated [DWI] or DUID) by observing the behavior/presentation of the individual and their surroundings. During a pre-arrest assessment of impairment, the officer may employ SFSTs (e.g., walk and turn). After arrest, individuals suspected of DUID (e.g., preliminary breath test reads below 0.08) may be evaluated by a certified DRE. The ability to assess potential impairment is enabled and informed through a combination of the officer's training and experience.

- **Documentation (to support the decision):** An officer's meticulous, thorough, and timely documentation that comprehensively records their observation and assessment from the point of the initial encounter is often critical to gathering, presenting, and preserving evidence that can be admissible in the adjudication of a DUID legal case. To help ensure this evidence is admissible, it is therefore critical for officers to document observations and interactions either traditionally using paper and pen or through audio and video capture. Capturing, assessing, and documenting DUID interactions are critical for successful prosecution and adjudication of a DUID offense.

- **Training (to support both observation and documentation):** Underpinning observation, assessment, and documentation are training programs that improve skills to handle these tasks appropriately.

Trainings, like DRE and ARIDE, teach officers to observe, identify, and articulate the signs of impairment related to drugs, alcohol, or both. A DRE is also trained to determine which category of the seven major drugs the driver may be under the influence of. Practitioners cited that these steps are critical to successfully and fairly prosecuting and adjudicating a DUID case; thus, this systematic approach to gathering and recording data that may be admissible as evidence is useful to keep in mind when considering how the application of new technologies might help law enforcement officers in the field. Immersive learning can enhance officers' awareness and empathy; similarly, next-generation real-time communications can connect officers with support, including DREs.

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25. Although this report focuses on applications relevant to DUID cases, these digital technologies have broader applications beyond DUID investigations.

26. This often requires a higher standard, such as proof of authentication and potentially an officer's or others' testimony to the veracity and meaning of the evidence.

LANDSCAPE

Like most industries today, over the past several years, public safety and national security agencies around the world have been embracing the cloud, mobile computing, big data, and other advanced technologies to radically reduce their operational costs and enhance successful outcomes.[27] Technology-enabled products and services are emerging to help law enforcement digitally enhance and transform operations and to support law enforcement officers in their jobs. Technology has the potential to enhance adjudication of DUID cases with improved consistency in both officers' actions and the preservation of evidence. Key technologies are continuously improving to enable the capture and analysis of visual and audible information from dashboard and body cameras, phones, and other recording devices. Improvements in the mobility (size and weight) and accuracy of the recordings (fidelity, resolution, and storage) are greatly augmented by their real-time interconnectivity and ability to access advanced software, including the use of AI and cloud computing. The intersection of these technology trends opens up new applications for law enforcement that will enhance DUID outcomes.

This section of the report offers a broad view of technologies and products of relevance when thinking about how technology might improve DUID outcomes. It is organized as follows:

27. Jacques, P. (2016, July 13). Digital transformation for public safety. *Police Professional*. Retrieved from https://www.policeprofessional.com/news/digital-transformation-for-public-safety/

TECHNOLOGY ADVANCES

Technologies driving digital transformation globally offer a future with enhanced DUID investigative outcomes.

Advancement in digital technologies is largely driven by consumer markets like smartphones and gaming, where the volumes are high and the consequences for failure of new features are relatively low. The capabilities, accuracy, and cost of these technologies continue to improve as adoption grows. Law enforcement and other niche market applications are beginning to take advantage of these technologies to assist, augment, and automate tasks. Wireless communication, mobile hardware, and cloud computing can help DUID investigations with improved real-time communication and immersive learning, as illustrated in **Figure 5**.

Convergence of Technologies Driving Digital Transformation

Technology Advances	Products and Services

5G Wireless Communication
- Improved cell infrastructure
- New wireless spectrums available
- Faster data transfer
- More reliable connections
- Improved encryption

Mobile Hardware
- Smaller/miniaturized
- Ruggedized
- Faster processing
- Low-light image processing
- Lower power need
- High-energy batteries
- Edge computing

Cloud Computing
- Access to massive computing power
- Able to utilize AI/machine learning advances for analytics and decision support
- Data storage
- Advanced security

1 Real-Time Communication

2 Immersive Learning

Wireless Communication

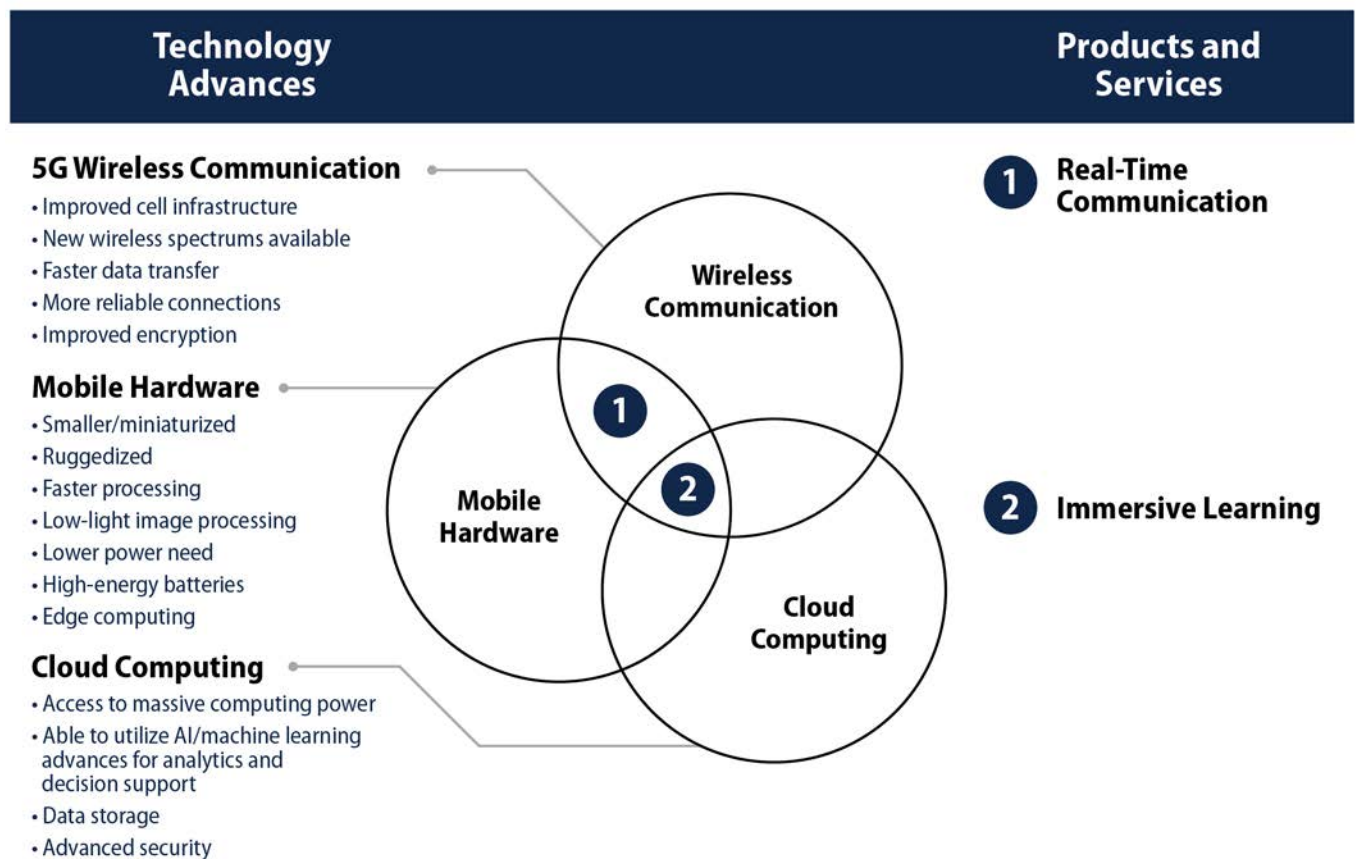*Mobile Hardware*

Cloud Computing

Figure 5: Hardware, software, and computing advances in commercial products will enable an improved digital future for law enforcement and DUID cases.

Advancements in broadband connectivity, hardware, and AI can increase successful case outcomes.

5G Wireless Communication

5G wireless communication advancements enable real-time remote services. Infrastructure for devices transmitting voice and data has improved significantly with 4G LTE; however, connectivity is still dependent on the location of cell towers. The next generation of telecommunication (5G), which operates at a different frequency spectrum, is expected to significantly improve bandwidth, speed, and latency.[28] 5G will also use 256-bit encryption, which is a substantial improvement on the 128-bit standard currently used by 4G networks. These higher security options may encourage law enforcement agencies to adopt real-time connected cloud-based services to enhance operations. Today, FirstNet (built by AT&T) has begun to deploy a private high-speed nationwide wireless broadband network for a limited number of devices and is dedicated to public safety. In the future, a separate private solution may not be necessary.

Mobile Hardware

Mobile hardware improvements enable smaller, more capable, easy-to-use devices. Newer cameras (dashboard and body) continue to offer advanced features such as high dynamic range recording that allows details to be captured across a wide range of lighting conditions, which prevents evidence from being washed out or lost in shadows. Advanced cameras may include infra-red LEDs that can capture detailed footage at night. Hardware advances to convert video and transmit digital information in real time enable mobile communication services. These recordings can provide accurate documentation of the vehicle in motion for potential later use during testimony. The recording may also be used to assist the officer in making an initial assessment of impairment, either via AI or through virtual support from a specialist. These hardware improvements also allow desk officers to view the same scene as in-field officers in real time, assisting both observation and decision-making.

Cloud Computing

Cloud computing expands computing power for analytics and AI by leveraging a network of remote servers hosted on the internet, rather than a local computer, to store, manage, and process data. This practice allows remote devices to leverage massive computing power to devices connected to the internet. This power can enable advanced analytics and AI applications to support officers in the field. Although AI has been around for many decades, recent advancements in computing power (Moore's Law), data availability (e.g., digitization and connectivity of sensor data), and advanced algorithms are driving broader adoption in industries such as banking, marketing, and entertainment. Over time, AI is expected to improve the ability to assist, augment, or automate several law enforcement tasks, including real-time scene assessment and analysis, and support observation, documentation, and training (see **Figure 6**).

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28. Purdy, A. (2019, September 23). Why 5G can be more secure than 4G. *Forbes*. Retrieved from https://www.forbes.com/sites/forbestechcouncil/2019/09/23/why-5g-can-be-more-secure-than-4g/#296e98ad57b2

The convergence of digital technologies continues to enable next-generation products.

Law enforcement is beginning to take advantage of products and services associated with digital transformation to improve efficiency and consistency. Software platforms running on real-time operating systems allow connection across different devices. Similarly, emerging products are enhancing situational awareness, including support from CAD as back-up, and real-time sharing of data and documentation.[29] Several vendors are taking advantage of these trends and now offer unified systems that agencies can procure, which include hardware, software, and associated services.

AI-Enabled Solutions May Enhance DUID Outcomes

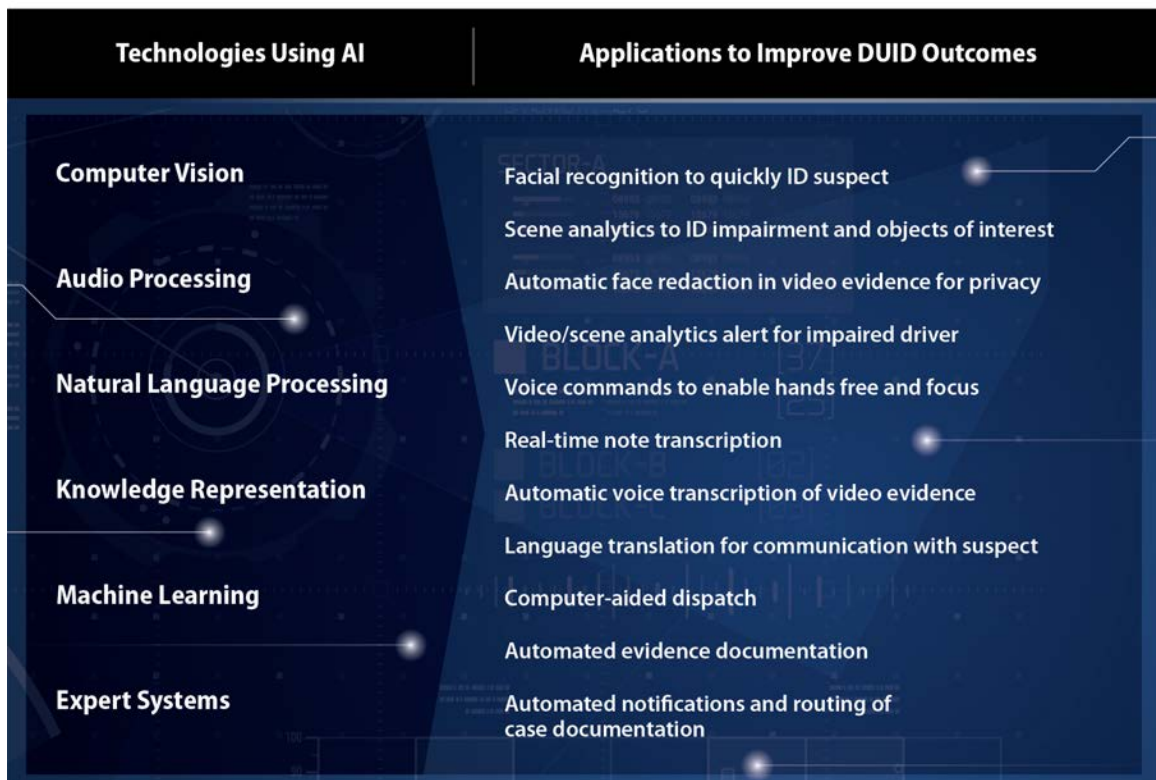| Technologies Using AI	Applications to Improve DUID Outcomes
Computer Vision	Facial recognition to quickly ID suspect
	Scene analytics to ID impairment and objects of interest
Audio Processing	Automatic face redaction in video evidence for privacy
	Video/scene analytics alert for impaired driver
Natural Language Processing	Voice commands to enable hands free and focus
	Real-time note transcription
Knowledge Representation	Automatic voice transcription of video evidence
	Language translation for communication with suspect
Machine Learning	Computer-aided dispatch
	Automated evidence documentation
Expert Systems	Automated notifications and routing of case documentation

Figure 6: Next-generation products will build on commercially available AI technologies to bring to market specific law enforcement solutions that could impact or address arrest, prosecution, and adjudication processes.[30, 31]

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29. The *sharing* of data to help inform/confirm an officer's observation or assessment does not automatically mean that this information can be admitted into evidence to help substantively prove the DUID charges; rather, the prosecutor may have to establish or demonstrate additional steps.

30. For further reading on AI in the criminal justice system, reference the previous CJTEC series on AI: Redden, J., Dix, M. O., & Criminal Justice Testing and Evaluation Consortium. (2020). *Artificial intelligence in the criminal justice system*. U.S. Department of Justice, National Institute of Justice, Office of Justice Programs. Retrieved from https://cjtec.org/technology-foraging/

31. Some of these AI products may have additional authentication or chain-of-custody requirements in order to be admissible in a DUID case. Prosecutors may have to take some additional steps to establish the credibility and authenticity of this documentation to demonstrate that the particular document/record has not been doctored/changed/fabricated.

PRODUCTS AND SERVICES TODAY

Real-time communication and immersive learning products and services can support observation, documentation, and training applicable to DUID.

Digital transformation products, including advancements in mobile hardware, cloud computing, and wireless communication may improve the capabilities of law enforcement officers during interactions with suspects in DUID cases. Opportunities exist for law enforcement to leverage these advanced capabilities in real-time communication and immersive learning to enable improved observation (situational awareness), documentation, and training abilities related to DUID cases (see **Figure 7**). This section presents background on enabling technologies and also uses specific products and services that are available on the market today to illustrate how officers' capabilities might be enhanced with next-generation communication, data capture and analysis, and training tools.

Products and Services Enabling Improved DUID Outcomes

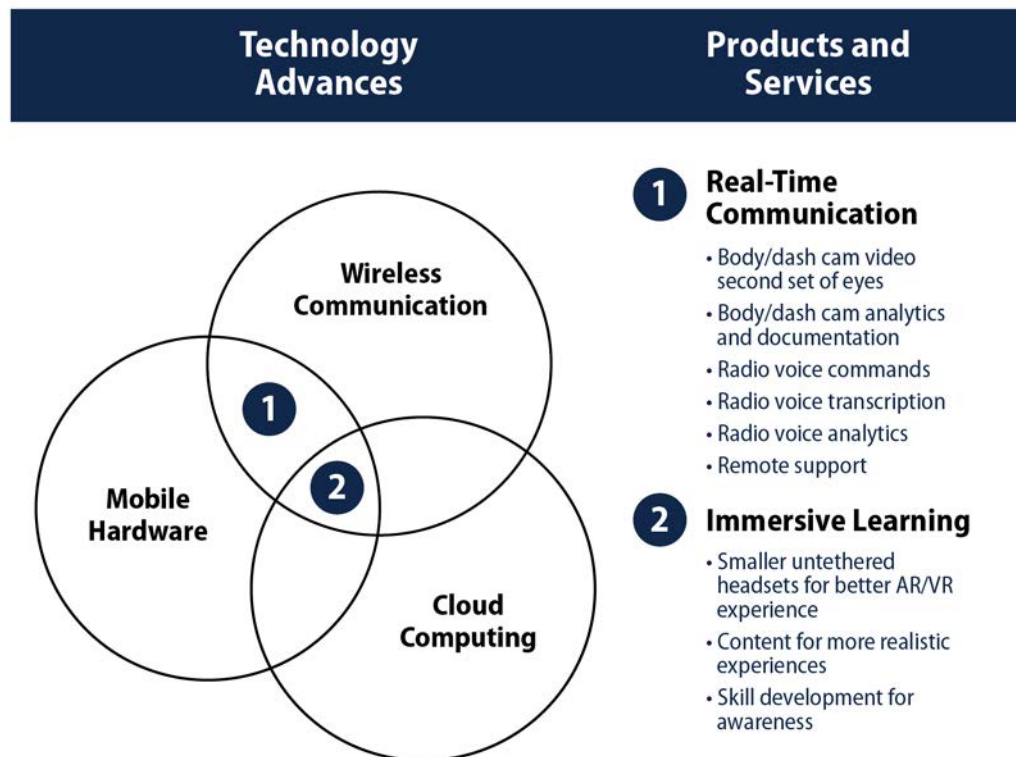| Technology Advances	Products and Services
Wireless Communication / Mobile Hardware / Cloud Computing	**1 Real-Time Communication** • Body/dash cam video second set of eyes • Body/dash cam analytics and documentation • Radio voice commands • Radio voice transcription • Radio voice analytics • Remote support **2 Immersive Learning** • Smaller untethered headsets for better AR/VR experience • Content for more realistic experiences • Skill development for awareness

Figure 7: Real-time communication and immersive learning products are shifting from consumer-based markets to law enforcement–specific applications.

Real-Time Communication

Observing and investigating potential DUID offenses typically begin in the field by an officer visually noticing something that prompts them to investigate. Having access to dispatch and other DUID-related support may help ensure proper procedures are followed. Thus, technology to connect the officer in the field with support is valuable if it can share and record video images and voice commands.[32] Products that enable this kind of connection via real-time communication can link to officers' radios, phones, cameras, and vehicles (see **Figure 8**).
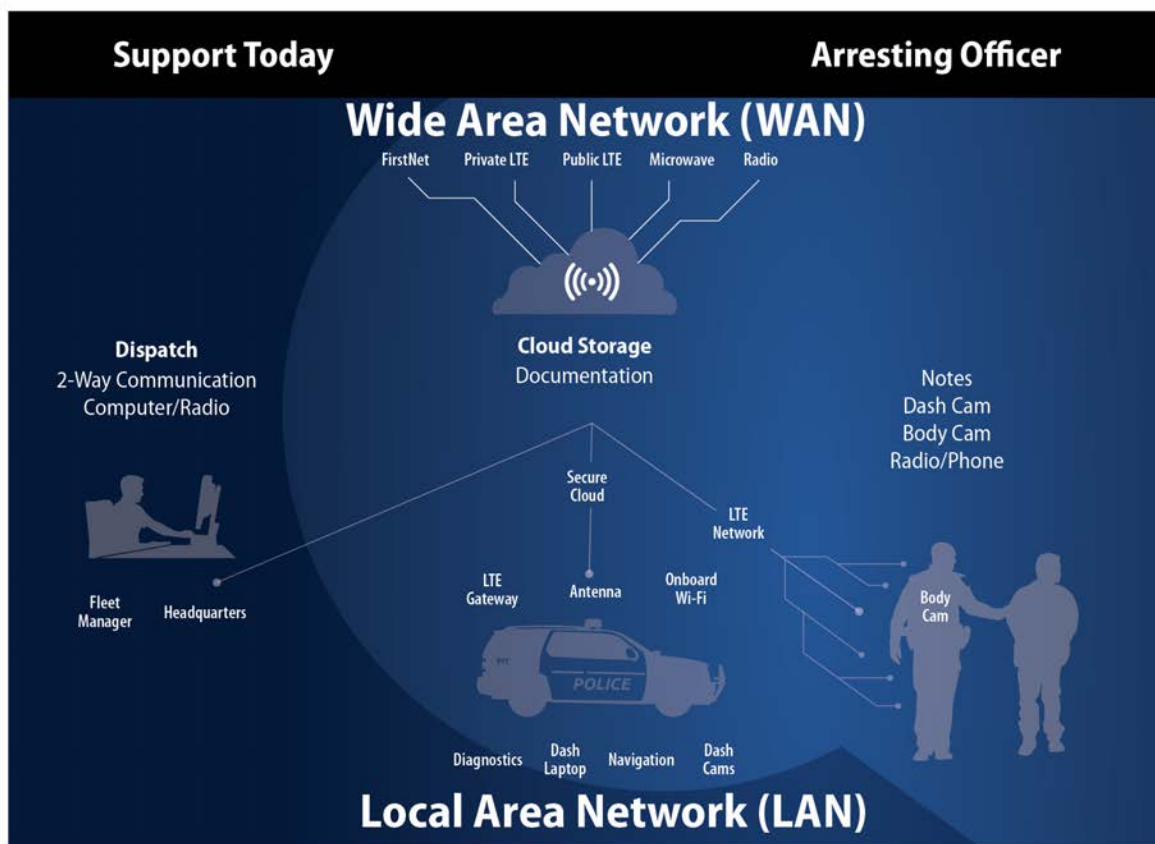
Figure 8: The emerging digital future for law enforcement to support investigation of incidents of DUID includes improvements in real-time communication.[33]

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32. The cost of storing video is one of the major drawbacks that prevents law enforcement agencies from purchasing in-car and body-worn cameras.

33. USAT. (n.d.). *Vehicle networks*. Retrieved from https://usatcorp.com/solutions/vehicle-networks/

Vehicles are communication hubs for officers in the field that enable immediate access to information and the ability to communicate with other officers, dispatch, and beyond.

Officers investigating incidents of DUID need access to the same real-time data and applications when they are on the road as when they are at the agency. Vehicle hubs give users access to mission-critical applications and the internet.[34] Where connections are available, hubs can enable continuous streaming of data to the cloud via onboard telemetry, sensors, and surveillance cameras. At the core of this capability is a mobile router that wirelessly accesses the internet.

A **vehicle hub** or router is a device that connects to the internet through a cellular link gateway.[35] The hub is part of a LAN within the vehicle and provides a single connection to the WAN, providing access to the internet. The ruggedized hub provides the 3G/4G/5G/LTE gateway and is typically installed in the trunk of the cruiser. Law enforcement routers need the ability to operate on a WAN, which includes a range of wireless frequency bands because cellular technology is evolving, and carriers operate on different bands. Some products offer dual-sim capability, allowing users to switch between cellular carriers, which is particularly beneficial for agencies that cover large geographic areas where carrier coverage may vary. Sierra Wireless and Cradlepoint are two examples of companies offering mobile routers primarily to law enforcement today:[36]

Sierra Wireless offers a mobile virtual private network specifically designed for mobile applications called AirLink Connection Manager.

Cradlepoint (recently acquired by Erickson) offers a number of routers and options, including Elastic EdgeSM, which provides a mobile network that delivers connectivity with NetCloud Services for mobile networks.

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34. The scope of such communications may be limited or governed by state/local and law enforcement laws, policies, and procedures.

35. Stockton, D. (2019). *In-vehicle connectivity: 9 important considerations when choosing a mobile router*. Retrieved from https://www.police1.com/police-products/communications/articles/in-vehicle-connectivity-9-important-considerations-when-choosing-a-mobile-router-t7taxkdqhOSM1lx3/

36. Duran, Y. (2020). Focus: Mobile router guide. *Police Fleet Manager Magazine*. Retrieved from https://hendonpub.com/focus-mobile-router-guide/

Improvements in real-time analysis of dash and body cam video can provide immediate support to the officer in the field.

Cameras[37] are widely used today in law enforcement, including both inward- and outward-facing dash cameras in police cars and body cameras. Benefits include improvements in conviction rates, officer professionalism, training, and protection from false accusations.[38] For incidents of DUID, dash and body cams may offer a record of the interaction to support officers' assessment of impairment. New products and services are working to address current drawbacks to these cameras such as:

- inadequately representing the actual situation because of limitations related to viewing angle, distance, and resolution;

- privacy concerns; and

- costs associated with both equipment and data storage.

Dash cams available today are compact, have integrated sensors and infrared LEDs, have higher resolution, enable quality imaging in low-light situations during nighttime DUID incidents, and can be connected to the cloud. The VIA Technologies Mobile360 D700 (**Figure 9**), with 4G LTE wireless and Wi-Fi connectivity capabilities, was introduced to the market in 2019.[39] Products offer both front- and rear-facing cameras on the dash and interior cameras able to record the back seat. Some cameras now offer 4K high resolution. Another capability of a real-time connected camera is an AI-enhanced integrated automatic license plate recognition, which can read license plates in multiple lanes simultaneously. This would enable an officer investigating a potential DUID suspect to automatically check for a previous warrant. Axon's Fleet 3 dash cam also connects to Flock Safety's public safety license plate readers, now in 400 cities, and enables cross referencing.[40, 41] Other companies offering dash cams include 10-8 Video Systems, Digital Ally, and Motorola Solutions.

Figure 9: The VIA Mobile360 D700 AI Dash Cam combines dual 1080p front dash and interior cameras with integrated 4G LTE wireless and Wi-Fi connectivity. (Image provided by Via Technologies)

37. Some vendors are developing products focused on documenting interactions during a DUID investigation. For example, Ocular Data Systems' DAX Evidence Recorder is an evidentiary recording device for roadside and drug impairment investigations that was highlighted in the previous DUID report. See https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/.

38. U.S. Department of Justice, Office of Justice Programs. (n.d.). *Impact of video evidence on modern policing*. Retrieved from https://bja.ojp.gov/sites/g/files/xyckuh186/files/bwc/pdfs/iacpin-carcamerareport.pdf

39. VIA. (2019). *The argument for dash cams in all police cars*. Retrieved from https://www.viatech.com/en/2019/07/why-all-police-cars-need-dash-cams/?cn-reloaded=1

40. Axon. (2020). *Axon partners with Flock Safety to enhance security for cities and neighborhoods*. Retrieved from https://investor.axon.com/press-releases/press-release-details/2020/Axon-Partners-with-Flock-Safety-to-Enhance-Security-for-Cities-and-Neighborhoods/default.aspx

41. Matsakis, L. (2019, October 24). Flock Safety says its license plate readers reduce crime. *Wired*. Retrieved from https://www.wired.com/story/flock-safety-license-plate-readers-crime/

Technologies to Enhance Observation, Documentation, and Training for
Driving Under the Influence of Drugs Enforcement

Smart voice services leverage high-speed data communication, AI, and cloud computing to enable real-time voice recognition and transcription, providing hands-free communication and improved situational awareness for officers investigating incidents of DUID.

Driven by the adoption of many other voice-enabled smart devices in the tech industry, the accuracy and capability of AI natural language processing continue to improve. Like many early technology advancements, voice services like Alexa, Siri, and Cortana were initially targeted to consumers conducting low-risk applications, like a web search. However, over the past few years and with better access to open-source AI tools and affordable cloud computing, the industry has seen software start-up companies like Otter and Voicea (recently acquired by Cisco) and other mobile app/web-based software companies create customizable **real-time transcription services** targeted to businesses. Large-scale cloud computing players like Amazon and Microsoft are not yet offering real-time support directly to law enforcement, but they are working with companies who use their cloud services and leverage these technology advancements.

Voice dictation and transcription for law enforcement have been around for many years.[45] These voice services can include **voice identification**, wherein the device or system can identify the person talking, and **voice transcription**, wherein the input audio signal is converted to written text of what was said or dictated. Historically, such voice services were supported by software loaded on a local computer to perform the natural language processing that creates the transcription. These kinds of voice services make creating incident reports and connecting and communicating with CAD/RMS systems by voice faster, safer, and more efficient. Nuance Communications, the developer of Dragon Speech Recognition Software, has been a leader in conversational AI for many years and is considered one of the largest players in transcription for specialized markets, like law enforcement.[46]

Like the newer voice services, Nuance has migrated from local computer-based products to a web-based application that can run on a mobile device. Nuance's value proposition seeks to replace a keyboard and mouse with a user's voice. As such, its transcriptions can be used to provide specific input to other applications (e.g., incident reports) where a law enforcement officer would normally enter text by typing. Nuance serves several specialty markets, like law enforcement, where they customize their products with industry-relevant terminology and jargon to improve translation accuracy. Nuance says it works with each police department to learn how they pronounce local commonly used terms such as street names and surnames. They also customize the service to enable transcriptions to use appropriate abbreviations and support efficient report writing. However, in discussions with representatives from Nuance, they noted adoption is slow.[47] Many businesses and agencies are reluctant to use voice services because they lack accuracy in areas such as recognizing regional and unique jargon, accents, and dialects.

With significant investment in voice services by the broader technology community, law enforcement may soon benefit by having options beyond Nuance's input capability and gain the capabilities of smart hands-free products and services. Companies like Axon are introducing products and services that will record conversations, which are then automatically transcribed and analyzed and provide automatic input to reports. By using hands-free capabilities, officers may improve situational awareness by keeping their eyes focused on their

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45. This is an example of a record that would need to be authenticated before it could be substantively admitted into evidence in a DUID case to verify the speaker and confirm that the voice record has not been altered.

46. Nuance Communications. (n.d.). *Dragon law enforcement police reporting software*. Retrieved from https://www.nuance.com/dragon/industry/dragon-law-enforcement.html

47. From interview with Michael Millward and Eric LaScola, Nuance Communications.

critical tasks. However, like all AI- and cloud-based offerings, security and privacy concerns present challenges and barriers to adoption, particularly for law enforcement.

For law enforcement environments, which can experience significant background noise, clear audio is needed for voice services (dictation, transcription, commands) and accurate translation whether by humans or software. Hardware, including microphones and advanced digital audio processing circuitry, is critical. Although smartphones today have microphones capable of voice services, companies like Philips and Olympus (**Figure 12**) provide higher-quality recording devices specifically designed for use in tough environments like law enforcement. These more sophisticated products offer audio enhancement features like **noise cancellation of ambient/background noise** with encryption capability to secure local recordings from unauthorized access and are ruggedized for impact resistance. These devices can also connect to Wi-Fi networks, enabling wireless transfer of the recording and access to cloud computing services such as voice commands and transcription. Philips and Olympus also offer complete packages for voice services (hardware, software, and storage), and both use Nuance's AI technology for their transcription.

Figure 12: The DS-9500 Digital Recorder, offered by Olympus, features Wi-Fi technology that allows users to quickly send dictations without needing to physically plug into a computer and a noise canceling system to improve dictation management efficiency. (Image provided by Olympus)

Audio recordings can be extracted from both body and dash cams. Axon just announced a new transcription service in which the initial offering will include a web-based **review assistant** and **transcribe assistant** to make corrections to a transcription.[48] Axon plans to add auto-transcription from all body camera footage (within minutes) to its online record management tool.

Bone-conduction headphones may enhance situational awareness by not blocking an officer's ear canal and enabling the officer to better hear surrounding noises.

Bone-conduction headphones, like Aftershokz, allow for private two-way communications while keeping the ears free by conducting audio signals through the cheekbones, which may enhance law enforcement's situational awareness. These headphones work by using transducers to send mini vibrations through the cheekbone directly to the inner ear, bypassing the eardrum.[49] Because they do not seal around or even touch the ear canal, they allow the user to hear their external environment more directly. Bose Corporation now offers sunglasses with bone conduction audio.[50] Touted as AR sunglasses, they currently only offer audio; however, Bose claims to be working on other AR capabilities. Bone-conduction headphone could be helpful for officers communicating with other actors (e.g., dispatch, other officers, emergency medical services personnel) who may be involved in DUID investigations, while also being able to hear what is happening on the scene.

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48. Axon. (n.d.). *Auto-transcribe review assistant*. Retrieved from https://help.axon.com/hc/en-us/articles/360052572654-Auto-Transcribe-Review-Assistant
49. Aftershokz. (n.d.). Home page. Retrieved from https://aftershokz.com/
50. Bose. (n.d.). *Frames*. Retrieved from https://www.bose.com/en_us/products/frames.html

Unified software platforms connect a suite of devices for real-time support to users, including automatic documentation and evidence management; however, the business model often includes subscription-based contracts.

Digitalization trends have allowed companies like Motorola Solutions, Visual Labs, Zepcam, Digital Ally, Axon, and BodyWorn to offer their customers a unified software platform. These companies have traditionally offered hardware products, such as dash and body cams, but are beginning to take advantage of real-time connectivity and cloud technologies to offer supporting services. These real-time operation systems can support DUID investigations by locating and tracking devices and providing communications and support to officers in the field, when they are connected to a cellular system or satellite, with

- efficient case documentation and evidence management by digitalizing and storing recordings, notes, and other relevant case management information;

- automatic image redaction and information sharing via digitalization of information; and

- permission-based access for users, eliminating the need to print and deliver hard-copy information.

One potential downside to these unified systems is eliminating the ability to mix and match products from multiple vendors. To take full advantage of the software platforms, an agency may need to commit to one vendor for all devices and software. These companies are creating as-a-service offerings for which agencies pay a subscription fee rather than buying the devices and software. This offering may allow agencies to adopt technology without huge upfront capital investments but may tie the agency to a given product/service based on subscription fees and contracts.

Although some law enforcement agencies may benefit from subscription models that eliminate up-front capital investment for the hardware, the model of a monthly fixed subscription fee per device/service is not necessarily inexpensive. Moreover, there is the additional, potential challenge that law enforcement agencies may not end up owning or having access to the content on these platforms when their contract ends, raising further concerns for longer-term record storage and sharing. Some subscription fees lock agencies into 5-year contracts, like Axon's Officer Safety Plan, which costs from $109 to $199 per officer per month.[51] As such, the cost of these new cloud-based services may be a barrier for small agencies. Although the up-front capital cost may be reduced or eliminated, migrating all the users to a new system with a monthly subscription fee can be prohibitive. Digital Ally recently announced a subscription service for in-car and body cameras starting at $50 per month per user.[52]

51. Overfelt, M. (2019, December 12). Taser-maker Axon is looking a lot more like Apple, Amazon, and so is the future of law enforcement. *CNBC*. Retrieved from https://www.cnbc.com/2019/12/12/taser-maker-axons-amazon-alexa-exec-is-future-of-law-enforcement.html

52. Digital Ally. (2020, June 8). *Digital Ally announced subscription program to enable law enforcement departments to purchase body cameras*. Retrieved from https://www.digitalallyinc.com/bodycamera-subscription-plan/

Immersive Learning

Identifying DUID-related impairment is complex and requires advanced training and consistency for fair adjudication. There was general consensus among the NIJ workshop participants that these training programs (particularly the DRE) are resource intensive, requiring time off to attend and complete the program. Participants also reported that many jurisdictions do not follow/teach the SFST program, leading officers to be inconsistently trained.[53] Broader access to cost-effective training is considered one of the key elements to improving DUID investigative outcomes. Today, the Drug Evaluation and Classification (DEC) Program is managed and coordinated by the IACP with support from NHTSA of the U.S. Department of Transportation.[54] The mission of the IACP's Technical Advisory Panel (TAP) is to develop, promote, and provide guidance and support for the DEC, ARIDE, and SFST.[55] One objective for TAP is to provide quality, timely training to ensure that the goals and objectives of the DRE, ARIDE, and SFST programs are met. These programs train officers at varying levels to best observe, react to, and document instances of impaired driving, as illustrated in **Figure 13**.
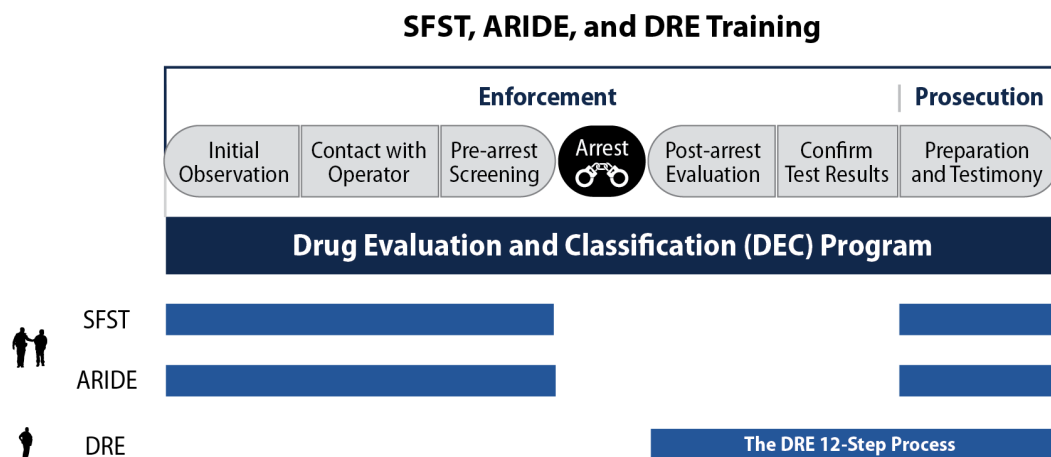
SFST, ARIDE, and DRE Training

Figure 13: Training is foundational to how officers interact with suspected impaired drivers; next-generation training will improve outcomes.

The SFST program trains officers to identify and assess drivers suspected of being under the influence of alcohol, whereas the DEC Program provides more advanced training to evaluate suspected drug impairment and to determine the category of the suspected drug.[56, 57] The SFST assessment is employed at roadside by a field officer who may also be a DRE. Post-arrest, the DRE conducts the 12-step process either at roadside, or when appropriate, in a more controlled environment, such as at a police department or detention facility. ARIDE is intended to bridge the gap between these two programs by providing officers in the field with a more specialized degree of skill and training than an officer who has completed only the SFST or another nonstandardized training. An ARIDE-trained officer may

53. Gourdet, C. Vermeer, M., Planty, M. G., Banks, D., Woods, D., & Jackson, B. A. (2020). *Countering drug-impaired driving*. Santa Monica, CA: RAND. Retrieved from https://www.rand.org/pubs/research_reports/RRA108-2.html
54. IACP. (n.d.). *The International Drug Evaluation and Classification Program*. Retrieved from https://www.theiacp.org/projects/the-international-drug-evaluation-classification-program
55. IACP. (n.d.). *Program oversight*. Retrieved from https://www.theiacp.org/program-oversight
56. IACP. (n.d.). *DRE training*. Retrieved from https://www.theiacp.org/dre-training
57. Until a determination is made that the driver is perhaps under the influence of something other than alcohol, the same steps are used by trained officers to process a suspected impaired driver.

additionally help make an informed decision about when to seek the assistance and involvement of a DRE. One of the most important aspects of ARIDE training is its reinforcement of the skills that are taught in the SFST program. The ARIDE program builds on these skills by developing officers' ability to identify different types of drug-related impairment, including but not limited to alcohol-related impairment. Only officers who demonstrate proficiency in the SFST program can attend the ARIDE program. The ARIDE program trains officers to secure appropriate biological samples to identify substances likely causing impairment.[58]

An effort by researchers from the University of Texas at Dallas and Sam Houston State University offers a look into the future for augmenting DUID training with advancements in technology. Researchers developed Brian, a virtual impaired driver through the Individuals Nystagmus Simulated Training Experience project.[59] Although not immersive learning, Brian combines 3D modeling, programming, and animation to create a lifelike appearance; mathematical algorithms map Brian's physical features and eyes that can follow and twitch when an officer moves his finger horizontally in front of the screen. Brian helps simulate what officers encounter when they perform horizontal gaze nystagmus (HGN) tests during traffic stops and is equipped with algorithms to give feedback on the officer's performance and technique.[60] Immersive technologies, as illustrated in **Figure 14**, offer platforms for augmenting DUID training.
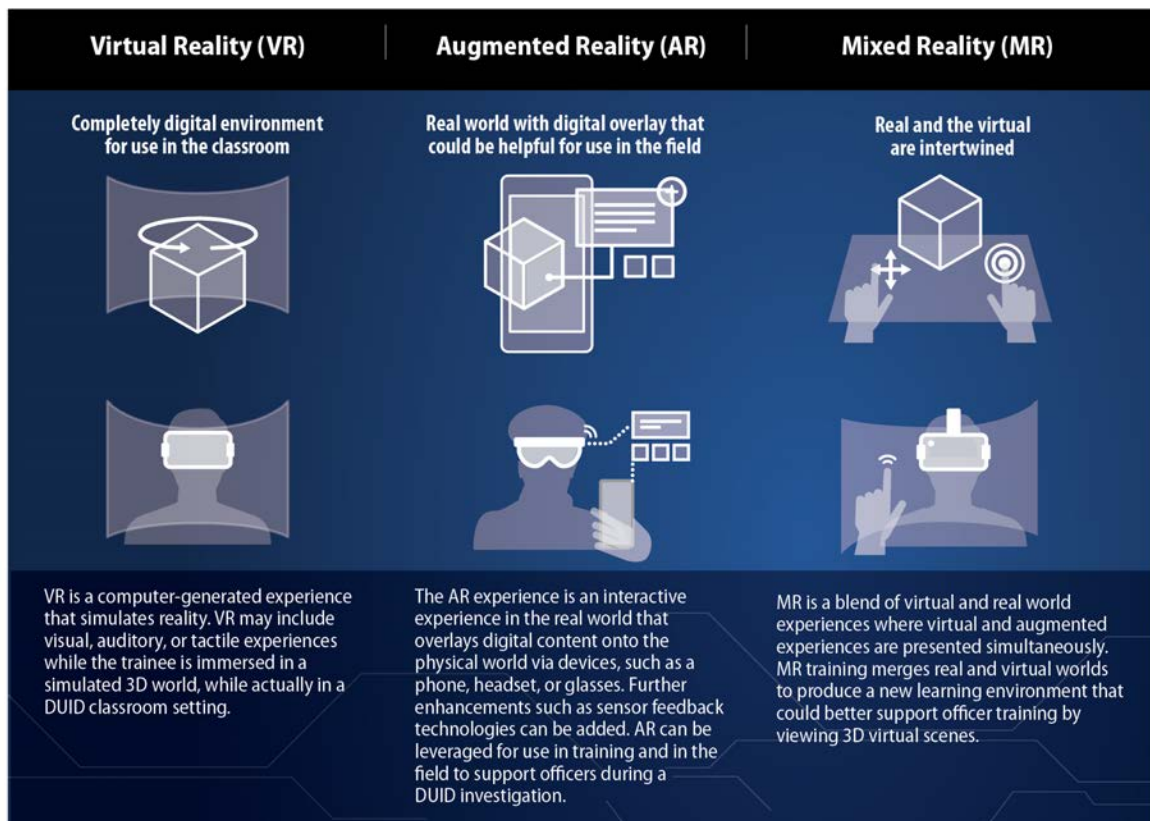
Figure 14: VR, AR, and MR are the foundational technologies underpinning immersive learning.

58. IACP. (2020). *DRE training*. Retrieved from https://www.theiacp.org/dre-training
59. University of Texas Dallas. (2019). *UT Dallas lab helps create virtual impaired driver for identifying DUIs*. Retrieved from https://www.utdallas.edu/news/science-technology/virtual-drunken-driver-2019/
60. Zielke, M. A., Zakhidov, D., Rizzo, J., DeFries, E., Trivedi, L., Marquart, C., Dusek, M., & Prochaska, J. (2019). Using design-based research to develop a virtual human interface for police nystagmus training. *IEEE 7th International Conference on Serious Games and Applications for Health (SeGAH)*, Kyoto, Japan. https://doi.org/10.1109/SeGAH.2019.8882475

Immersive technologies provide platforms for new forms of training and situational support.

Immersive technologies are a family of computer software and hardware systems that allow users to replace or supplement physical environments with digital media. As previously illustrated in **Figure 14**, VR, AR, and MR could be leveraged to support DUID training in a cost-effective and accessible format, including allowing officers to train during their shifts for small periods of time, eliminating travel for training, and eliminating costs associated with staffing.

Implementing immersive training environments for DUID cases can assist law enforcement officers in three key areas:

1. **Familiarization** through realistic, high-resolution 3D models allows for visual and spatial familiarity with the virtual environment. In a virtual training environment, familiarization could help officers experience the physical movements and enhance situational awareness when approaching a vehicle driven by a person suspected of DUID.

2. **Scenario/situational** training is a more complex environment that is interactive and intended to replicate situations and responses. This training could be done by requiring a police officer to go through a particular DUID investigation protocol and simulating an interaction and response to the situation. Situational training can be leveraged to allow officers to move and interact with a virtual impaired driver in various situations that could be customized and interactive to provide realistic feedback from the interactions. Axon offers a related VR Empathy Training that teaches officers the skills to respond to situations involving individuals with mental health conditions.

3. **Assessment** training allows for both the instructor and the student to review the performance metrics against protocol for the various scenarios and provide feedback. It could include biofeedback from wearable sensor technology taken during the scenario to look at stress levels. For example, an ARIDE and DRE training could potentially measure the suspect's eye movements to determine whether the officer properly administered an eye movement test. It could also determine whether the process steps were followed in the correct sequence.

CJTEC **INSIGHT**

Existing Validation Efforts Related to Immersive Learning Outcomes

A number of studies have been performed to show the effectiveness of immersive learning across many industries:

A 2017 randomized controlled trial in the *Journal of Oral Maxillofacial Surgery* that sought to evaluate the effect of using VR surgery on the self-confidence and knowledge of surgical residents showed significantly greater perceived self-confidence levels compared with those in the control group.

A 2018 study in *Surgical Endoscopy* found interactive VR-based hands-on training to be a relatively inexpensive and effective mode for teaching operating room fire prevention and management scenarios.

A 2019 study in *Computer Applications in Engineering Education* suggested that AR intervention has a significant positive impact on student laboratory skills and that the development of an AR learning environment is an effective tool in reducing the cognitive load of students while operating laboratory equipment.

A 2020 study in the *Journal of Bone and Joint Surgery* demonstrated how an immersive VR system can efficiently teach a complex surgical procedure and demonstrate improved translational skills and knowledge acquisition when compared with a traditional learning method.

Small, wireless, high-performance headsets provide a realistic immersive experience and are driving adoption of AR and VR for training globally.

Although VR and AR technology have been around for many years, initial adoption had been slow because the technology was expensive and awkward to wear; heavy headsets were tethered to computers, and users often experienced associated motion sickness. Over the past 10 years, advancements in digital transformation technologies have enabled several headset manufacturers to produce small, wireless, high-performance products that provide a realistic immersive experience, although most still use animations. A recent industry report from Fortune Business Insights predicts continued growth in VR/AR companies and capabilities over the next several years, driven by training and simulation across a number of markets worldwide.[61] As investment increases, the quality and impact of immersive training will improve, which could translate to expansions in applications for law enforcement.[62] VR headsets and platforms currently used for immersive training include the following:

- **Facebook's Oculus:** Axon's VR Empathy-Based training leverages Facebook's Oculus Headset (**Figure 15**) to better equip officers with the tools to de-escalate situations involving people suffering from mental health issues, crises, or psychotic episodes.[63]

- **HTC's VIVE Pro:** Street Smarts VR uses the HTC VIVE Pro to carry out its suite of police training scenarios, including motor vehicle/traffic stops, suspicious subject, and communications training.[64]

- **HP Reverb G2 Omnicept Edition:** HP recently announced this new product, which includes a state-of-the-art sensor system that measures muscle movement, gaze, pupil size, and pulse and seamlessly transfers data to the HP Omnicept platform.[65]

Figure 15: Facebook's Oculus Quest 2 is an all-in-one VR device that offers an untethered VR headset for a more realistic immersive experience. (Image provided by Facebook)

> **Immersive training would be hugely important for our training, particularly SFST, ARIDE, but also for portions of the DRE training. The closer we can get the training to real-life training the better!**
>
> Kyle Clark
> IACP

Law Enforcement **INSIGHT**

61. Fortune Business Insights. (2019). *Market research report*. Retrieved from https://www.fortunebusinessinsights.com/industry-reports/virtual-reality-market-101378
62. As advancements in haptics technology improves it will enhance the sensations and real-life experience of virtual environments.
63. Axon. (2019). *Axon VR empathy-based training*. Retrieved from https://www.officer.com/training-careers/specialized-training/product/21082743/axon-axon-vr-empathybased-training
64. Street Smarts VR. (n.d.). *Discover the future of de-escalation training*. Retrieved from https://www.streetsmartsvr.com/law-enforcement
65. HP. (n.d.). *HP Omnicept & HP Reverb G2 Omnicept Edition*. Retrieved from https://www8.hp.com/us/en/vr/reverb-g2-vr-headset-omnicept-edition.html?jumpid=va_cdbrzpgewu

Immersive technologies can improve both technical skills and soft skills associated with DUID cases.

Currently, the immersive training content broadly falls into training technical skills, soft skills, or both. Technical skills focus on learning and improving specific skills through simulated experiences, which is particularly advantageous for risk-free repetition of complex or dangerous technical tasks. Soft skills focus on helping develop human skills such as empathy for positive social interactions, like customer service or provision of feedback. Although companies developing immersive training programs using AR/VR for law enforcement do not offer DUID-specific training today, they typically offer other public service and military training programs. Offerings come from the following:

Established training companies for law enforcement and other related markets, like Apex Officer and Ti-Training, are expanding their officer training programs by adding AR/VR offerings. Apex Officer has now created a library with over 50 law enforcement–related training scenarios, including modules for de-escalation, use of force, crisis intervention, and active shooter.[66] Although they do not offer specific DUID training modules, they do offer modules for vehicle pullovers, traffic crash investigation, arrest, and control and DUI transport.

Law enforcement product-development companies, like Axon, are using VR training for their products and services. Axon, a taser manufacturer, has offered traditional forms of training for its products for many years. Currently, it is making a strong push to incorporate VR in product training and introduce VR Suicide Empathy Training. The training is designed to help officers develop empathy and confidence when responding to calls for individuals in crisis.[67]

Start-up companies, like GoVRed, SurviVR, and Nsena, are leveraging a combination of immersion technology (VR/AR) expertise with seasoned law enforcement officers to develop training platforms and services targeted to public safety, first responder, military, and law enforcement.[68] V-Armed specializes in custom 3D VR simulations for large-scale military and law enforcement training. Multiplayer scenarios enhance mission readiness and situational awareness by using a variety of sensors and lifelike tools such as weapons to enable realistic environments. Nsena worked with the Philadelphia Department of Corrections to provide familiarization, a virtual experience for juvenile offenders to experience a halfway house to help reduce anxiety and enhance outcomes.[69] With a continued push to offer realistic virtual environments, UK-based start-up RiVR offers photorealistic scenarios. RiVR Investigate offers a near-to-life immersive presence in fire and crime scenes. To ensure a high-fidelity photorealistic scene, RiVR records actual controlled-burn fires.

Law Enforcement INSIGHT

> **Immersive learning is becoming one of the hottest and most transformational approaches to learning in business. New tools for VR and AR are transforming technical, managerial, and all elements of soft skills training because they create real-world learning experiences that stick.[70]**

Josh Bersin
Global Industry Analyst

66. Apex Officer. (n.d.). *Police training scenarios*. Retrieved from https://www.apexofficer.com/scenarios
67. Axon. (2019). *Axon launches virtual reality suicide empathy training for law enforcement*. Retrieved from https://www.axon.com/news/axon-launches-virtual-reality-suicide-empathy-training
68. SurviVR. (n.d.). *A breakthrough in first responder training*. Retrieved from https://survivr.com/
69. Kim, C. (2018). Introducing inmates to real life via virtual reality. *U.S. News*. Retrieved from https://www.usnews.com/news/best-states/articles/2018-03-15/introducing-inmates-to-real-life-via-virtual-reality
70. JFF. (n.d.). *Workplace training redefined*. Retrieved from https://www.jff.org/events/workplace-training-redefined/

Equipment and content customized for law enforcement are beginning to provide realistic training experiences beyond the classroom or videos.

Typically, vendors offer two options for immersive training: an agency can buy its own equipment with access to a library of training software modules or pay for prepackaged training capabilities for a price per user that enables access to fully customized training equipment and content. Examples include:

- Ti Training's Recon Augmented Reality Training provides equipment for flexible space and screen setup options with AR glasses to recreate situations with interactive content for active-shooter situations, de-escalation, field interviews, and many others. Ti Training has also teamed up with RealMax to provide a new AR component to video-based training. The RealMax AR glasses enable trainees to have an unobstructed view of the training room with a 100-degree field of view. In addition to actors, props, such as a patrol car, cover and concealment, and bystanders, can be introduced into the training room to provide a more realistic training experience.

- SurviVR, a California TechStars start-up, pivoted its VR development agency to focus on law enforcement applications for safety, judgment, and response time. SurviVR claims to offer hyper-realistic imagery by hiring artists to create scenes.

- StriVR, a start-up founded by a Stanford graduate, developed a unique approach to VR for quarterback training. The technology provides a realistic and immersive environment for the quarterback to practice without being hit by setting up cameras on the field during a real practice. The technology also enables coaches to see where the quarterback is looking to help them better understand what the quarterback was doing and provide more relevant feedback. StriVR now offers immersive training programs to several industries. StriVR operates a partnership model wherein it supports a customer through the selection, procurement, and configuration of all required hardware and provides complete on-site physical setup and support.

Today, no AR/VR immersive training programs are specifically designed for DUID training situations such as ARIDE or DRE; however, the immersive nature of the technology would make it a good fit to complement and reinforce the content taught in these programs. DUID-specific immersive training programs enable a safe, realistic, and potentially lower-cost training option for DRE and ARIDE. With the legalization and potential increased use of cannabis that may lead to cannabis-impaired driving, one of these current companies will likely begin offering DUID training in the future. With improvements in haptics, these trainings could offer very real-to-life immersive training environments for each step in the DUID process:

- Observation of (1) vehicle driving behaviors that may indicate impairment, (2) interaction with driver and passengers in many scenarios, and (3) vehicle interior (people/objects) in a variety of situations

- Augmentation of (1) ARIDE training program with immersive learning and (2) DRE training with haptic feedback with VR to simulate a person under the influence's response, vitals, etc.

Driven by better data analytics and AI, education and training in all fields and contexts can become highly individualized, restricting the need to train personnel using a cohort-based approach. Immersive training could augment both preservice training at the academies and in-service training within agencies. Training spaces can be assembled quickly to allow agencies to offer continual training and testing to demonstrate competence and reinforce skills. In the future, automated or semi-automated systems will assess student knowledge, provide more customized instruction that emphasizes areas of deficiency or student interest, and better assess student competency.[71]

The total cost of immersive training goes beyond the cost to the vendor and also includes administration (including systems) related to registration, levels of evaluation, instructors, curriculum development, and venue; however, as technology advances and interest in immersive training grows, funding from federal and state sources may help offset costs for agencies. Though not specific to DUID cases, Congressman Tim Ryan introduced a bill in 2019 to fund immersive training for law enforcement.[72]

These immersive systems, when coupled with smarter educational platforms, will do a stronger job of developing officers and their skill sets by placing them in realistic scenarios that respond to officers' decisions, actions, gestures, commands, and even tone of voice.[73]

Law Enforcement **INSIGHT**

Police Chief Magazine
2017

71. Slawson. D. (2019). The case for VR-immersive and AI-adaptive soft skills training. *Training Industry*. Retrieved from https://trainingindustry.com/magazine/mar-apr-2019/the-case-for-vr-immersive-and-ai-adaptive-soft-skills-training/

72. U.S. Congress. (2019). H.R. 2329: Law Enforcement Immersive Training Act of 2019. Retrieved from https://www.govtrack.us/congress/bills/116/hr2329

73. Schafer, J. A., & Jarvis, J. P. (n.d.). The landscape of police education and training 2037. *Police Chief Magazine*. Retrieved from https://www.policechiefmagazine.org/the-landscape-of-police-education-and-training-2037/

POTENTIAL FUTURE

A shortage of DUID-specialized officers, compounded by the increase in cannabis use (medical and recreational), underscores the need for additional resources that can support officers in the observation, documentation, and testimony in DUID cases.[74] Digital technologies, applying AI, VR, and AR, may be leveraged to further support officers investigating incidents of DUID by helping to identify suspicious behaviors, establish probable cause, and detect impairment. Additionally, remote and virtual technologies, largely driven by telehealth, can increase the accessibility of trained DREs through a remote DRE system. Key technology advancements driving digital transformation will continue to evolve[75] and help law enforcement officers investigate and prosecute DUID cases, as illustrated in **Figure 16**.

As advancements in technology continue, devices will get smarter, offering improved opportunities for implementation with DUID cases.

As the hardware miniaturization and AI software capabilities improve, new products that support officers investigating DUID cases may emerge. These enhanced smart devices may be capable of offering remote support and enhancing real-time situational awareness, offering real-time situation-dependent procedural guidance and automated documentation. These capabilities would enable more consistent evaluations and documentation of the DUID suspect, which could, in turn, lead to fair adjudication.

Future Technologies to Enhance DUID Enforcement
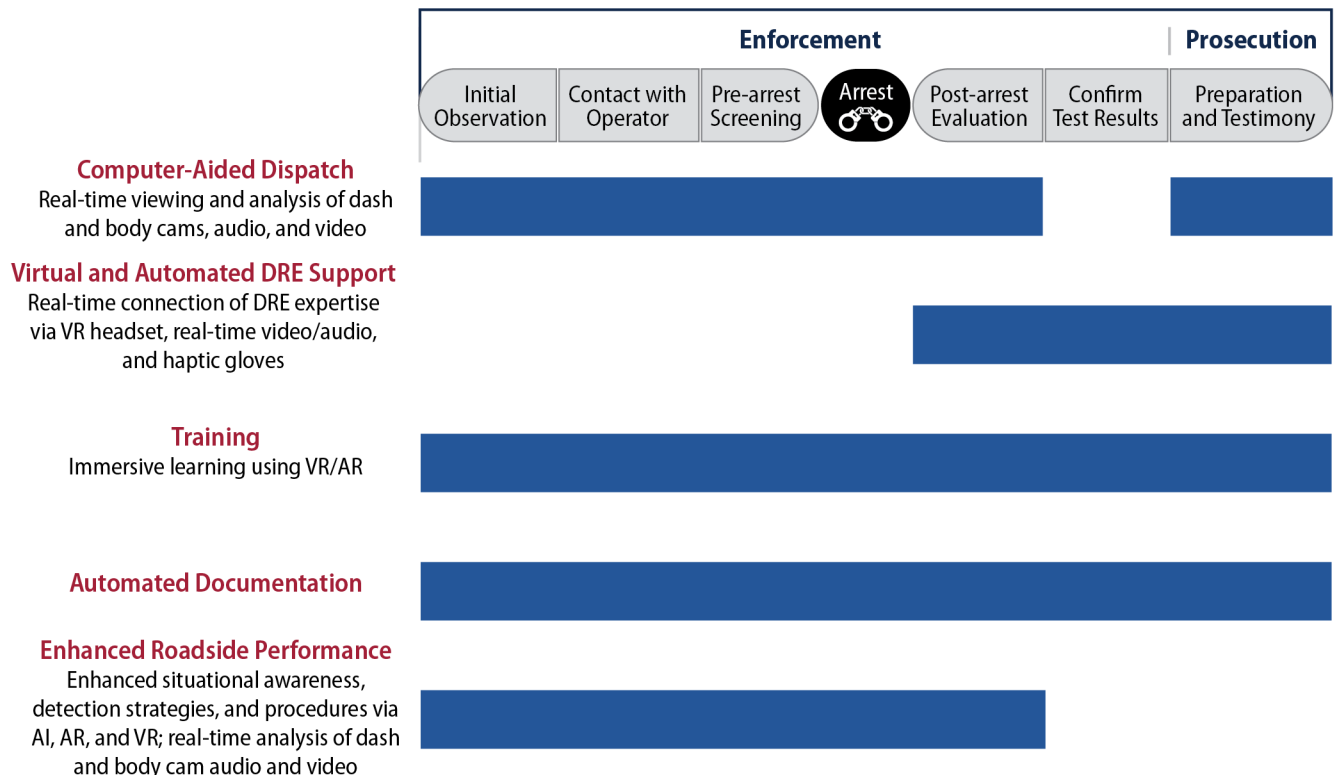
Figure 16: Future technologies may enhance observation, assessment, and documentation for incidents of DUID.

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74. American Academy of Family Physicians. (2020. March 4). *Cannabis use in older adults continues upward trend*. Retrieved from https://www.aafp.org/news/health-of-the-public/20200304cannabisuse.html

75. Other future technologies that could help DUID investigations include real-time language translation, real-time voice analysis, and Vehicle-to-Vehicle (V2V) communication.

As AI technology continues to develop, its intersection with dash- and body-cam technology suggests a range of possible future applications that could affect law enforcement and the handling of DUID cases. AI has evolved to include human behavioral inputs and insights, which, when coupled with physical data, can be used to evaluate human-machine cooperation. This kind of AI augmentation fits with officers' needs to observe and consider drivers/operators in the complex working environment, which is inherent in most DUID incidents. The following technologies illustrate some future possibilities of using AI to identify suspicious behaviors via video analytics, augment video observation, and help detect drug-induced impairment, which can help law enforcement in DUID incidents by enhancing situational awareness while making observations for probable cause and driver screening.

Initial Observation

Today, systems are offered to commercial fleet operators to monitor and notify their drivers of behaviors that are indicative of reduced driver performance. Although not directly used for observing drivers suspected of DUID, these AI-based video systems point to the parallel possibilities of using body cams on the scene of a DUID investigation to observe and identify behavioral indicators of drug impairment, which could be used to support probable cause and help bolster field screening of drivers.

Two examples of today's remote driver monitoring products are the VIA Mobile360 Driver Monitoring System and the Affectiva Automotive AI for Driver Monitoring Systems.

Another interesting use of AI that has potential relevance to observing drivers suspected of DUID is Driveway's patented AI technology to automatically observe safe and unsafe driving behaviors from a driver's smartphone using a GPS hardware component, a network-based position estimation component, and a data processor.[76, 77] It is not a video observation, but it does suggest future capabilities that could have significant impact on DUID enforcement activities. Although Driveway's products target voluntary adoption, for example, for benefits to be offered by insurance companies,[78] vehicle manufacturers, insurance companies, or state and federal regulators could require adoption of such systems. This adoption could be very helpful in reducing incidents of DUID in the first place and, if they do occur, providing additional observational capabilities using AI.[79]

Significant investments in AI may drive the development of DUID-specific products.

Autonomous vehicles (AVs) have emerged as one of the most significant technology trends of today and have driven significant investment to develop AI to enable improved AV operation. AVs can make decisions based on various sensor and image inputs, but the complexity of an almost endless number of unique driving scenarios places a significant limit on what AVs can achieve today. DXC Technology Company, in a recent white paper "Making AI smart enough for autonomous vehicles," explains how leading tech firms and automakers are developing AI using machine learning that can help make fully AVs a reality.[80] The Massachusetts Institute of Technology offers another example of how AI can be used to understand the egotistic behavior of drivers in nearby vehicles so that the subject vehicle can adjust its driving decisions accordingly.[81] The use of similar AI approaches to augment police car dash-cam video analysis of other vehicles to look for drug-induced driving behavior is only a slightly different application of the same underlying AI capability and could offer significant opportunities to enhance law enforcement observation and detection of DUID cases.

76. Driveway. (n.d.). *Curing car crashes*. Retrieved from https://www.driveway.ai/

77. Katsman, I. (2018). Systems and methods for handheld device based battery efficient context monitoring, detection of a vehicular motion and identification of a specific vehicle. *U.S. Patent No. 9,869,772(B2)*. Washington DC: U.S. Patent and Trademark Office.

78. Cision PR Newswire. (2019, September 4). *Zurich Insurance Company Ltd and Driveway Software launch smartphone-based telematics platform to power new mobility solutions*. Retrieved from https://www.prnewswire.com/news-releases/zurich-insurance-company-ltd-and-driveway-software-launch-smartphone-based-telematics-platform-to-power-new-mobility-solutions-300911125.html

79. The widespread ability of law enforcement to access and use this information may be restricted by privacy laws.

80. Andric, D. (2019). *Is AI smart enough for autonomous vehicles*. DXC Technologies. Retrieved from https://www.dxc.technology/auto/insights/146977-making_ai_smart_enough_for_autonomous

81. Wiggers, K. (2019). MIT's AI scores driver egotism to make autonomous vehicles more assertive. *VentureBeat*. Retrieved from https://venturebeat.com/2019/11/18/mits-ai-scores-driver-egotism-to-make-autonomous-vehicles-more-assertive/

Video analytics may support officers in identifying suspicious behaviors, such as erratic driving, for incidents of suspected DUID. The PATSCAN VRS Video Recognition Software by PatriotOne Technologies is a video analytics threat detection package that can be used in real time or for forensics analysis of security situations, including identification of suspicious behavior of individuals. ReconaSense offers a similar AI-enabled solution for improving observation and detection in security applications, including using video analysis of suspicious behaviors. Similar approaches to leveraging AI in video analytics could augment law enforcement observation of suspicious driving behavior as probable cause and the screening of operator behavior to detect drug-induced anomalies. With AI, there may need to be a "human in the loop" to avoid situations related to machines making decisions without oversight. Additionally, it has been well documented that AI technologies may reinforce racial bias, causing law enforcement agencies to back away from using these technologies.[82]

Contact with Operator and Pre-arrest Screening

AI to Support Investigation

Emerging AI video analysis could be directed at both the suspect's general behavior and their behavior in response to specific prompts and questions. This analysis could potentially automate some steps of the DRE 12-step process, such as a nystagmus test, and enable remote monitoring of driver behavior with inward-facing dash cams. Extensive research has examined how AI can be leveraged to interpret body language and understand people's emotions and states of mind.[83, 84, 85] Using AI to interpret people's states of mind and behavior could be applied to automate some steps of the DRE 12-step process, including those embodied in the technologies presented above.

AR/VR to Detect Impairment

The emergence of AR/VR, in combination with AI analysis, could be a powerful combination that may help reduce potential human error from DRE evaluations and establish fully objective, documentable, and repeatable analyses. VR is the subject of tremendous amounts of research for its use in treating mental and behavioral disorders and detecting drug impairment. Beyond those that are in the previous DUID report, examples include the following:

Figure 17: SyncThink's EYE-SYNC is an FDA-approved modified VR headset with infrared cameras that connect wirelessly and securely to a tablet. The system provides an assessment of abnormal patterns that are indicative of a particular visual impairment. (Image provided by SyncThink)

- SyncThink, Inc. (**Figure 17**) has developed a technology using VR headsets to track eye movement to evaluate neurocognitive performance. The technology is already in use today, mainly in health care settings, sports teams, and the military.

- Altoida uses an AR framework that allows testing of complex, everyday functions in a gamified and fun way, while directly interacting with a user's environment, to detect the onset of Alzheimer's disease.

82. Cumming-Bruce, N. (2020, November 26). U.N. panel: Technology in policing can reinforce racial bias. *New York Times*. Retrieved from https://www.nytimes.com/2020/11/26/us/un-panel-technology-in-policing-can-reinforce-racial-bias.html

83. Science of People. (n.d.). *How AI will revolutionize how we use body language*. Retrieved from https://www.scienceofpeople.com/body-language-ai/

84. Tucker, P. (2019). Here come AI-enabled cameras meant to sense crime before it occurs. *Defense One*. Retrieved from https://www.defenseone.com/technology/2019/04/ai-enabled-cameras-detect-crime-it-occurs-will-soon-invade-physical-world/156502/

85. Future implementation of this type of technology would need to consider the consistency and accuracy across different cultures.

- Tobii VR (**Figure 18**) partners with headset manufacturers to develop eye-tracking technology in VR. Tobii Ocumen is its premium eye-tracking solution designed to deliver advanced real-time data streams and filters optimized for the development of VR applications in domains such as health assessment, therapeutics, and research. This technology may be used to train and assess officers for DUID procedures and may one day be able to assess and measure impaired drivers for HGN and VGN.

Figure 18: The Tobii VR4 Eye Tracking Platform leverages the HP Reverb G2 Omnicept Edition to enable detection of eye movements and measurements of pupil dilation (pupillometry,) which can be used together with input from a photoplethysmography sensor for measuring heart rate. (Image provided by Tobii)

AR Glasses to Support Situational Awareness

Further down the road, AR glasses and AR contact lenses could enhance officers' situational awareness and assist in DUID investigations. AR glasses or smart glasses are eyewear with integrated technology to merge the real world with virtual information overlain on one of the glasses' lenses. Today, manufacturers such as Vuzix (**Figure 19**) and Epson offer small lightweight glasses that are finding applications for enterprises and education that are outpacing gaming and entertainment.[86] Technology companies like Facebook, who recently announced a partnership with Ray-Ban, are investing heavily in the AR/VR space to introduce smart glasses.[87, 88] These headsets are expensive, but as adoption grows, the cost is expected to drop. Small, lightweight glasses can be used to assist and inform officers investigating DUID cases. Officers wearing these devices enhanced with AI may experience improved situational awareness, advise on suggested next steps, and assist in the automatic documentation of DUID investigations in real time.

Figure 19: Vuzix Blade Upgraded Smart Glasses offered by Vuzix provide access to location-centric information, data collection, and remote support communications with both audio and video. (Image provided by Vuzix)

Related to smart glasses, Mojo Vision recently announced that it is working with the U.S. Food and Drug Administration to fast-track the use of their contact lenses by those with impaired vision. Though not yet in commercial development, Mojo Vision is developing a screen that fits on a contact lens, enabling users to view AR images directly from their eyeballs. As AR becomes more commonplace, companies wishing to sell glasses to those with vision impairments will likely have to adjust their prototypes to keep up. If lenses such as Mojo's work as promised, new creative uses, such as for DUID support, could be imagined.

86. Marr, B. (2020). The 5 biggest virtual and augmented reality trends in 2020 everyone should know about. *Forbes*. Retrieved from https://www.forbes.com/sites/bernardmarr/2020/01/24/the-5-biggest-virtual-and-augmented-reality-trends-in-2020-everyone-should-know-about/?sh=7a9c899524a8

87. Heaney, D. (2020). *Facebook confirms Ray-Ban partnership for 2021 "smart glasses."* Retrieved from https://uploadvr.com/facebook-ray-ban-smart-glasses/

88. Tech@facebook. (n.d.). Facebook reality labs. Retrieved from https://tech.fb.com/ar-vr/

> ## Continued advancements in AR systems may help DUID situational awareness and support for non-DUID-specialized officers in the field.
>
> AR technology's use of AR headsets and smartphone technology can provide an overlay of the real environment on computer-generated sensory input such as sound, GPS, or other data. Although not currently used by law enforcement, AR can be leveraged for the following:
>
> - **Field Policing:** AR products can enhance situational awareness via external data-enhanced sensing and processing. New capabilities can log locations, listen for gunshots, stream video, flag license plates, scan databases, and go on virtual patrol. These capabilities increase officers' awareness of environments.
>
> - **Management and Awareness:** Smart sensors can compile many types of information to help officers do their jobs faster, more effectively, and with more information. AR can be used to leverage additional data such as maps, team member locations, and biometrics to make better management and field operation decisions.
>
> - **Evidence Gathering:** AR headsets with video, computer vision, distancing tools, GPS, and communications can provide less experienced officers with a virtual expert that can see, hear, direct, and make notes. This support may help record data that otherwise may be missed. *This also relates to the virtual DRE considered below*.
>
> AR systems can support officers by doing the following:
>
> - **Enhancing data** collection through optics, zoom, audio, night vision, infrared, thermal, and the integration of any other sensor (e.g., chemical, biological, explosive).
>
> - **Recording data**, such as officer biometric data, GPS location, live video, distances, maps, images, and video.
>
> - **Processing data**, such as face or voice to allow instantaneous identification and translation, for example.
>
> - **Visualizing information** such as overlay data (e.g., directions, criminal intelligence, friend or foe, best practices, hot spot locations, floor plans) onto a 3D space to reveal features officers may not otherwise be able to see. Such information enables officers to quickly access data critical to effectively performing their duties.
>
> - **Enabling interaction** through a new interface via gestures, eye gazes, and voice commands with smart products and machines. Interactions can include coordination with robots and drones and improved communication with teams by using more information.

Post-arrest Evaluation

To date, the DRE evaluation process has not been viewed as technology constrained; thus, there has not been much effort on developing new technology to change or enhance the individual tests involved in the DRE evaluation itself. Today, the challenges are more thought to be a function of the limited resources available to support the cost of extensive training of DREs.[89] To address the limited number of DREs, emerging technologies may be able to remotely augment portions of the 12-step process. However, a significant challenge to adoption may be the technologies' ability to provide scientific evidence that would be admissible in court.[90]

Remote DRE support may address the shortage of certified DREs to work with officers in the field.
The growing use of telemedicine provides a roadmap on how virtual and remote technology can be leveraged for DUID cases. Telemedicine is increasingly being used by doctors to diagnose, monitor, and treat patients via internet-connected video or audio.[91] Many platforms are available to support the growing use of telemedicine. One example is Zoom for Healthcare, which specifically addresses privacy and security issues associated with personal health information. Chiron Health, another example of a telehealth platform, offers a package with full integration into insurance, billing, and related

89. Governors Highway Safety Association. (2018). *Drug-impaired driving*. Retrieved from https://ghsa.org/sites/default/files/2018-05/GHSA_DrugImpairedDriving_FINAL.pdf
90. Byrne, M. (2020, February 23). Case shows testing for impaired motorists has flaws. *Portland Press Herald*. Retrieved from https://www.pressherald.com/2020/02/23/case-of-wrongfully-accused-bus-driver-casts-doubt-on-ability-to-identify-drugged-drivers/
91. Cohn, S. (2020). *Telemedicine could change the way you visit your doctor. Are we ready?* CNBC. Retrieved from https://www.cnbc.com/2020/01/09/telemedicine-could-change-the-way-you-visit-your-doctor-are-we-ready.html

office workflows. Similar virtual and remote technologies could be used by DREs. The evaluation done by a DRE, as illustrated in **Figure 20**, relies on a nationally standardized battery of tests where the police officer examines a suspect's vital signs, involuntary biological reactions, and behavior to form an opinion on impairment.[92] A police officer, assisted by a DRE via video, could carry out some aspects of DUID observation and assessment testing remotely.[93]

Although remote support to field officers could happen in the near future, keep in mind that because DUI/DRE cases can result in arrest and incarceration it is critical for a DRE to get it right. Technology may be slow to be accepted until products can accurately replicate the in person, up-close interaction between the officer and the subject. Virtual interactions must provide the ability to detect subtle clues that a DRE may observe to detect impairment when in person. Several steps are not even close, particularly drawing blood for analysis and determining muscle tone; however, some research suggests remote support might be possible.

Detecting driver impairment

Some of the factors examined:

Pupil size
- Eye movements
- Pupillary reaction to light/darkness

Body temperature

Blood pressure

Resting heart rate
- Balance and coordination
- Muscle tone
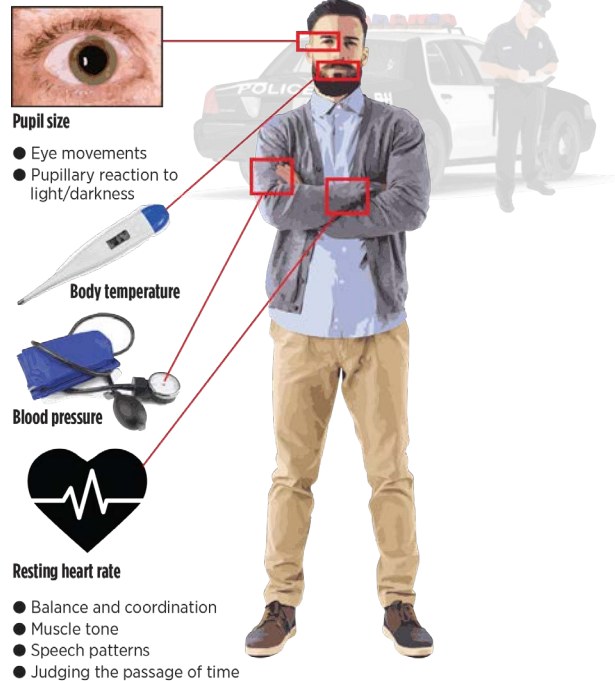- Speech patterns
- Judging the passage of time

Figure 20: DREs evaluate a DUID suspect's vital signs, involuntary biological reactions, and behavior in order to form an opinion on a driver's impairment. Remote video technologies could help officers in the field carry out some aspects of the evaluation. (Graphic by Michael Fisher, Portland Press Herald)

Figure 21: Mitra, offered by Neoteryx, uses a microsampling technology to simplify remote blood specimen collection by collecting blood without a syringe. (Image provided by Neoteryx, LLC)

Blood Collection: Today, Neoteryx's Mitra (**Figure 21**) devices provide a way to collect blood (or other bio-fluids) without a syringe using volumetric absorptive microsampling (VAMS) technology. Microsampling technology enables collection of very tiny amounts of blood that are enough to evaluate the drug levels and the biochemistry parameters of blood. A blood micro-sample is a sample of less than or equal to 50 μl. Samples of 10 to 30 μl are enough to analyze blood, plasma, or serum chemical exposure. Neoteryx says it will introduce a touch-activated device that can be placed on the upper arm to micro-puncture only the upper layers of the skin.[94] It has 30 thin needles that work like a leech to draw blood. As a result, a 100 μL of blood are drawn in a matter of 2 minutes.

92. Byrne, M. (2020, February 23). Case shows testing for impaired motorists has flaws. *Portland Press Herald*. Retrieved from https://www.pressherald.com/2020/02/23/case-of-wrongfully-accused-bus-driver-casts-doubt-on-ability-to-identify-drugged-drivers/

93. The use of virtual/remote technology would need to support both evidence gathered to inform decision-making in the field and evidence that is admissible in a DUID case.

94. Neoteryx. (2020, March 12). *Taking blood without using blood work needles: new age blood sampling*. Retrieved from https://www.neoteryx.com/microsampling-blog/cutting-edge-blood-sampling-devices

These new technologies, coupled with blood testing improvements that need lower quantities of blood for analysis, may enable a field officer to take blood samples during a DUID investigation without waiting for or becoming a qualified phlebotomist. For implementation in incidents of DUID, the reliability and accuracy of these tests would have to be verified, and officers would need to be trained in using this equipment properly.

Future with Telepresence: Further in the future, it may be possible to truly have a remote DRE, as illustrated in **Figure 22**, who would be able to "see and feel" what the officer in the field does. Telepresence refers to a set of technologies (including VR, sensors, haptics, robotics, and high-speed communications) that allow a person to feel as if they are present at a place other than their true location. The Human Fusions Institute is a leading research organization focused on "connecting the human brain, technology, and society through neural interfaces enabling the human mind to transcend the barriers of the body to achieve humanity's full potential." Today, their work primarily focuses on helping amputees "feel" through prosthetics and telehealth applications, and they have demonstrated a person "feeling" an object thousands of miles away. Someday, a remote DRE might be able to "see and feel" a DUID suspect and remotely administer the 12-step process including taking vital signs, drawing blood, testing eye movements, and checking muscle tone.

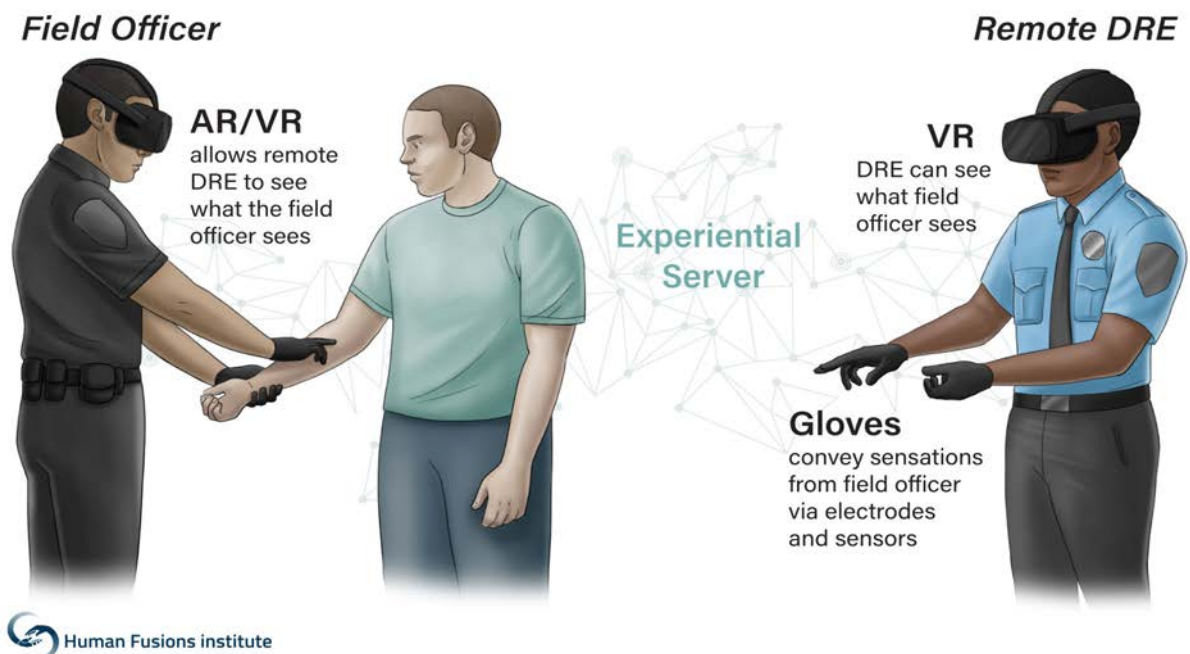## Future Technology: Remote DREs

Figure 22: Telepresence technology may someday support a remote DRE through AR, VR, sensors, and haptics. (Image provided by Human Fusions Institute)

BARRIERS TO ADOPTION

As considered in this report, technologies and products are emerging in consumer and business applications that are affecting, and will continue to affect, the criminal justice system broadly and DUID investigations specifically. With any technology, technical, economic, and social drivers and challenges affect the rate of development and adoption.[95] Below we discuss some of the barriers to adoption. Some are reasons why uptake by the criminal justice community might be slow, which then can affect the development of products specifically for criminal justice and DUID cases. Adoption by users signals market strength to product developers that they can use to justify investment in new products and features.

- **Technology Readiness:** For many products, accuracy is not yet at the level needed for widespread use for law enforcement applications.

- **Lack of Standardized Laws/Policies/Operational Procedures and Training:** Law enforcement agencies make different decisions about what type of DUID-related training to offer to officers, which can shape and inform how individual officers respond to a potential DUID incident.[96]

- **Cost:** The hardware/software and personnel to implement, train, and maintain emerging digital technologies may be prohibitive for many police departments.

- **Prosecution Standards:** Jurisdictions, even within a state, have varied and unique considerations, evidentiary thresholds, and legal standards for DUID cases.

- **Data Security, Quality, and Defensibility:** Use of cloud and wireless technology raises security concerns, and AI and predictive analytics introduce issues related to transparency and bias.

- **Evidence Admissibility:** Many DUID technologies affect issues that may conflict with or potentially violate certain legal or constitutional protections that uphold individuals' rights to privacy, to be free from unreasonable search or seizure, and to not be targeted on the basis of a particular demographic characteristic. Additionally, implementation of these technologies must consider the scientific reliability and admissibility in court.[97, 98]

Future Research and Evaluation Needs

Reflecting on the research and key findings, a future with technology-based products and processes is possible. This future is enabled by technologies that positively impact how officers are able to observe drivers that might be under the influence of drugs and how they are able to document their interactions and decisions. The use of immersive learning could be an efficient and effective training tool to improve officer situational consistency when responding to DUID incidents. However, before this future becomes a reality, there is additional research needed to

- Systematically consider DUID practices, both successful and in need of improvement, and barriers to adoption of specific solutions/enhancements[99]

- Develop solutions specific to DUID-centric needs

- Conduct evaluations to compare solutions, including technology assisted training with more traditional training methods specifically for DUID

- Complete evaluations or pilot studies to support agencies in their policies, procedures, and procurement decisions prior to large-scale adoption, including implications related to both privacy and civil rights

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95. Van Ness, L. (2020). Body cameras may not be the easy answer everyone was looking for. *The Pew Charitable Trusts*. Retrieved from https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2020/01/14/body-cameras-may-not-be-the-easy-answer-everyone-was-looking-for

96. All DREs are trained the same way.

97. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993).

98. *Frye v. United States,* 293 F. 1013 (D.C. Cir. 1923).

99. Dr. Cory Haberman, an Assistant Professor in the School of Criminal Justice and Director of the Institute of Crime Science at the University of Cincinnati, is conducting research to understand law enforcement officers' perceptions about VR training, how they would use it, and whether they would take it seriously. https://nij.ojp.gov/bio/cory-haberman-0.

APPENDIX

Glossary

3G/4G/5G/LTE
Generations of wireless mobile telecommunications technology.

4K Resolution
The 4K resolution standard for television and monitors is 3,840 x 2,160 pixels.[100]

Advanced Roadside Impaired Driving Enforcement (ARIDE)
A 16-hour training course for law enforcement officers to better identify signs of impairment caused by substances beyond alcohol. ARIDE "is intended to bridge the gap between the SFST and DRE course and to provide an enhanced level of awareness to the participants, both law enforcement and other criminal justice professionals, in the area of drug impairment in the context of traffic safety."[101]

Augmented Reality (AR)
AR is a broad discipline encompassing a wide range of methods that seek to create machines that mimic human intelligence.[102] The AR experience is in the real world with virtual overlays seen by a headset or glasses and felt by other sensor feedback technologies.

"The" Cloud
In computing, the cloud refers to storing and accessing data and programs online, instead of through a computer's hard drive.[103]

Computer-Aided Dispatch (CAD)
Systems used by dispatchers, call-takers, and 911 operators to prioritize and record incident calls, identify the status and location of responders, and effectively dispatch responder personnel.[104]

Digital Transformation
Digital transformation is the process of using digital technologies to create new—or modify existing—business processes, culture, and customer experiences to meet changing business and market requirements.[105]

Driving Under the Influence of Drugs (DUID)
DUID generally refers to offenses involving the operation of a vehicle while impaired as a result of drug use; every state prohibits driving while impaired by drugs, but states differ as to what is a drug, whether consent for testing is implied, and what concentration of drugs within the body constitute impairment.[106]

Driving While Intoxicated (DWI)
Any criminal action related to driving or operating a motor vehicle while "illegal per se" or while impaired by, under the influence of, or intoxicated by alcohol or other drugs. Related terms with similar meaning include driving under the influence (DUI), operating while intoxicated, and operating under the influence.[107]

100. Finnell, K. (2017). *4K video resolution*. SearchUnifiedCommunications. Retrieved from https://searchunifiedcommunications.techtarget.com/definition/4K-video

101. IACP. (2013). *Advanced Roadside Impaired Driving Enforcement (ARIDE) participant manual*. Retrieved from https://www.wsp.wa.gov/breathtest/docs/dre/manuals/ARIDE/2013/ARIDE_student_5-2013.pdf

102. Shute, R., Ovington, T., & Criminal Justice Testing and Evaluation Consortium. (2020). *Landscape study of field-portable DUID screening products*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Retrieved from https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/

103. Griffith, E. (2020, June 29). What is cloud computing? *PC Magazine*. Retrieved from https://www.pcmag.com/news/what-is-cloud-computing

104. Department of Homeland Security. (2011). *Computer-aided dispatch systems*. Retrieved from https://www.dhs.gov/sites/default/files/publications/CAD_TN_0911-508.pdf

105. Salesforce. (n.d.). *What is digital transformation?* Retrieved from https://www.salesforce.com/products/platform/what-is-digital-transformation/

106. Foundation for Advancing Alcohol Responsibility. (n.d.). *State Law: DUID Affirmative Defense*. Retrieved from https://www.responsibility.org/alcohol-statistics/state-map/issue/duid-affirmative-defense/

107. NHTSA. (2017). *Digest of impaired driving and selected beverage control laws*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812394-digest-of-impaired-driving-and-selected-beverage-control-laws.pdf

Technologies to Enhance Observation, Documentation, and Training for Driving Under the Influence of Drugs Enforcement

Drug Recognition Expert (DRE)

An individual who successfully completed the 100–124 hours of training requirements established for certification as a DRE by the International Association of Chiefs of Police (IACP) and NHTSA. DREs are highly effective officers skilled in the detection and identification of persons impaired by alcohol and/or drugs. DREs are trained to conduct a systematic and standardized 12-step evaluation that considers physical, mental, and medical components.[108]

Encryption

A process that encodes a message or file so that it can be read only by certain people. Encryption helps protect the confidentiality of digital data stored or transmitted through a network.[109]

Field-Portable DUID Screening Products

Products (including hardware-based and primarily software products, tests, and other technologies) that are used to support observations of an individual's impairment or presence of drugs or metabolites in their system for DUID investigations in a setting outside of a controlled laboratory, such as the roadside.

Horizontal Gaze Nystagmus (HGN)/Vertical Gaze Nystagmus (VGN)

Nystagmus is the medical term used to describe the involuntary rhythmic side-to-side, up and down, or circular motion of the eyes.[110]

Immersive Learning

Leveraging technology such as AR, virtual reality (VR), and mixed reality (MR) to create a simulated learning environment.[111]

Internet of Things

A network of physical objects that are embedded with sensors, software, and other technologies to enable the connection and exchange of data with other devices over the internet.[112]

Local Area Network (LAN)

A group of computers located in the same room, on the same floor, or in the same building that are connected to form a single network.[113]

Long-Term Evolution (LTE)

A standard for wireless data transmission for mobile devices that enhances speed and capacity.[114]

Mixed Reality (MR)

A blend of virtual experiences and the real world wherein virtual and augmented experiences are presented simultaneously[115] so virtual objects can be overlaid into a real-world scene.

Per Se Laws

Laws that make it illegal to drive with an amount of a specified drug in the body that is equal to or exceeds a set limit; relevant drugs vary by jurisdiction, and they may include (but are not limited to) alcohol and tetrahydrocannabinol.[116]

108. IACP. (2020). *DRE training*. Retrieved from https://www.theiacp.org/dre-training

109. Grace, A. (2020, July 24). *What is encryption and how does it protect your data?* Norton. Retrieved from https://us.norton.com/internetsecurity-privacy-what-is-encryption.html

110. John Hopkins Medicine. (n.d.). *Nystagmus*. Retrieved from https://www.hopkinsmedicine.org/health/conditions-and-diseases/nystagmus

111. Kumar, J. (2020, January 24). *Everything you need to know about immersive learning*. eLearning Industry. Retrieved from https://elearningindustry.com/everything-need-know-about-immersive-learning

112. Oracle. (2020). *What is IoT?*. Retrieved from https://www.oracle.com/internet-of-things/what-is-iot/

113. Network Encyclopedia. (n.d.). *Local area network*. Retrieved from https://networkencyclopedia.com/local-area-network-lan/

114. T-Mobile. (n.d.). *What is LTE?* Retrieved from https://www.t-mobile.com/resources/what-is-lte

115. Kiger, P. (2020). *What is mixed reality?* The Franklin Institute. Retrieved from https://www.fi.edu/tech/what-is-mixed-reality

116. NHTSA. (2010). *Drug per se laws: A review of their use in states*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/811317.pdf

Preliminary Breath Test

Sometimes referred to as a portable breath test, this pre-arrest breath test is administered during an investigation of a possible DWI violator to preliminarily obtain an indication of the person's blood alcohol concentration.[117]

Probable Cause

More than mere suspicion; facts and circumstances within the officer's knowledge, and of which he or she has reasonably trustworthy information, are sufficient to warrant a person of reasonable caution to believe that an offense has been or is being committed.[117]

Standardized Field Sobriety Test (SFST)

A battery of tests developed to determine whether an individual has a blood alcohol concentration at or above 0.10 g/dL, and later 0.08 g/dL. The battery of tests includes HGN, Walk and Turn, and One Leg Stand.[117]

Virtual Private Network (VPN)

A data network that enables two or more parties to communicate securely across a public network by creating a private connection.[118]

Virtual Reality (VR)

A computer-generated experience that simulates reality.[119] VR may include visual, auditory, or tactile experiences, and the trainee is immersed in this created 3D world.

Wide Area Network (WAN)

A geographically distributed network composed of LANs joined into a single large network using services provided by common carriers.[120]

Zero-Tolerance Laws

State laws that make it illegal to drive with any measurable amount of specified drugs in the body.[121]

117. NHTSA. (2015). *DWI Detection and Standardized Field Sobriety Testing (SFST) refresher*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/sfst_pm_refresher_manual.pdf

118. National Institute of Standards and Technology. (2002). *Security guide for interconnecting information technology systems*. Retrieved from https://csrc.nist.gov/publications/detail/sp/800-47/final

119. IGI Global. (n.d.). *What is virtual reality*. Retrieved from https://www.igi-global.com/dictionary/virtual-reality/31773

120. Network Encyclopedia. *Wide area network (WAN)*. Retrieved from https://networkencyclopedia.com/wide-area-network-wan/

121. Governors Highway Safety Association. (2020). *Drug impaired driving*. Retrieved from https://www.ghsa.org/state-laws/issues/drug%20impaired%20driving

Resources

Gourdet, C. Vermeer, M., Planty, M. G., Banks, D., Woods, D., & Jackson, B. A. (2020). *Countering drug-impaired driving*. Santa Monica, CA: RAND. Retrieved from https://www.rand.org/pubs/research_reports/RRA108-2.html

Governors Highway Safety Association. (2018). *Drug-impaired driving*. Retrieved from https://ghsa.org/sites/default/files/2018-05/GHSA_DrugImpairedDriving_FINAL.pdf

IACP. (2018). *IACP Drug Evaluation and Classification Program: 2019 annual report*. Retrieved from https://www.theiacp.org/sites/default/files/2020-04/2019%20DECP%20Annual%20Report.pdf

IACP. (2020). *DRE training*. Retrieved from https://www.theiacp.org/dre-training

IACP. (n.d.). *Drug recognition experts (DREs)*. Retrieved from https://www.theiacp.org/drug-recognition-experts-dres

IACP. (n.d.). *The International Drug Evaluation and Classification Program*. Retrieved from https://www.theiacp.org/projects/the-international-drug-evaluation-classification-program

National Highway Traffic Safety Administration. (2009). *Drug-impaired driving: Understanding the problem & ways to reduce it*. Retrieved from https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/811268.pdf

Redden, J., Dix, M. O., & Criminal Justice Testing and Evaluation Consortium. (2020). *Artificial intelligence in the criminal justice system*. U.S. Department of Justice, National Institute of Justice, Office of Justice Programs. Retrieved from https://cjtec.org/technology-foraging/

Shute, R., Ovington, T., & Criminal Justice Testing and Evaluation Consortium. (2020). *Landscape study of field-portable DUID screening products*. Washington, DC: U.S. Department of Justice, Office of Justice Programs, National Institute of Justice. Retrieved from https://cjtec.org/landscape-study-of-field-portable-duid-screening-products/