

UIC RAILWAY SYSTEM DEPARTMENT
CES Las Vegas 2023
Technical Report

April 2023



INTERNATIONAL UNION
OF RAILWAYS

ISBN 978-2-7461-3277-1

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Introduction by François Davenne, Director General of the UIC

International Union of Railways (UIC) is the worldwide railway organization, with over 200 members in 95 countries from every continent, representing 2,783 billion passenger.km, 8,991 tonne.km, 801,357 route.km, and 6,013 million rail staff. UIC gathers the vast majority of the European railway operators, main railway operators from every other continent, universities and research institutes and associations such as AAR¹ or RSSB². UIC has developed synergies with around 100 leading institutions, such as World Bank, international standardization organisations (ISO, IEC, CEN-CENELEC, ETSI), railway authorities (ERA³, etc.), railway regulator (FRA⁴), and Intergovernmental Organisation for International Carriage by Rail (OTIF⁵).

Adaptation to climate change is becoming a major concern, shared worldwide, and the urgency of which has just been recalled by the IPCC⁶. As a result, **UIC published its “Vision of Rail in 2030”**, encouraging the allocation of funds to invest in the **improvements of railway infrastructure, rolling stock and services**, as well as **innovation to decarbonise operations**, in order to drastically increase the number of trains, the number of passengers and freight carried worldwide.

Innovation! That is the reason why CES Las Vegas is so important for the UIC.

I would like to warmly thank Mr. Gary Shapiro, who in a visionary way, strongly supported the presence of the UIC at CES in Las Vegas. Thus, UIC has been active at CES Las Vegas and CES Government since 2017, participating in conferences and panels, delivering keynote speeches, and supporting the promotion of rail. In 2023, UIC increased its presence at CES even further.

Thanks to CES Las Vegas 2023, it is possible for railway stakeholders from all over the world to identify the main trends in innovation.

Thus, I have the pleasure to present you the first edition of the UIC technical report on CES Las Vegas.

We intend to publish this technical report annually, to share with railway stakeholders these main trends in innovation, as well as specific innovations to monitor for potential transfers to the railways.

We hope you will appreciate our report on shop.uic.org.

We look forward to your comments and encouragement on shop.uic.org.

¹ AAR: Association of American Railroads

² RSSB: Rail Safety and Standards Board (UK)

³ ERA: European Union Agency for Railways

⁴ FRA: Federal Railroad Administration (USA)

⁵ OTIF: The Intergovernmental Organisation for International Carriage by Rail (OTIF)'s raison d'être is the provision of a unified railway law for international trains. For this purpose, OTIF has implemented suitable procedures for cooperation between the state level and the railway economic sector level. See OTIF Bulletin 3/2028 pages 5 and 6 “OTIF: A CONCEPT OF LEGISLATIVE HARMONISATION BASED ON PARTNERSHIP” available at https://otif.org/fileadmin/new/5-Media/5B-Bulletin/2018/Bulletin_3_2018_EN.pdf

⁶ Intergovernmental Panel on Climate Change (IPCC) (2023), “Urgent climate action can secure a liveable future for all”, Online, Available at https://www.ipcc.ch/report/ar6/syr/downloads/press/IPCC_AR6_SYR_PressRelease_en.pdf (Accessed 20 March 2023)

⁷ UIC (2021), “Design a Better Future”, Online, Available at <https://uic.org/IMG/pdf/uic-design-a-better-future-vision-of-rail-2030.pdf> (Accessed 1 November 2021)

The authors

Francis Bedel and **Christian Chavanel** are the authors this report, with the help of **Jean-Michel Evanghelou** and **Gilbert Reveillon**.

Francis Bédel

Francis Bédel took responsibility of the IT service of the Worldwide Railway Organisation (UIC) in 2015 and endorsed the position of UIC Chief Digital Officer with the development of the UIC Digital Platform. UIC Digital Platform aims at supporting UIC Members in their digital activities and developments on a worldwide basis and following the philosophy “Share, Open, Connect”. He endorsed these responsibilities till 2021.

Francis Bédel started his career at French Railways SNCF in 1982, filling such roles as traffic manager and manager of freight stations.

In 1990, he joined SNCF’s IT Department to work on the rollout of a national project aiming to redesign the management of Freight wagons and, from 1993 to 1997, was responsible for the operation of Freight IT local bases.

Francis Bédel has been in charge of International Affairs for Freight IT at SNCF and among other issues, was European interoperability projects and ensured the relationships with the European Commission.

Francis was RAILDATA President from 2013 until the end of 2016. He is also active in many other international activities and projects.

Francis is personally committed for over 20 years in volunteer social activities and mostly in humanitarian missions in Western Africa focusing on childhood and education and is chairing since 2019 an association which manages residences for the youth in the Parisian area.

Christian Chavanel

Christian Chavanel is a railway professional with more than 35 years experience in international development, project management, operations, maintenance, safety, standardization, and regulatory affairs for the railway sector.

He is an engineer, and a graduate of an Executive MBA (ESSEC & Mannheim).

He holds a MIT certificate on ‘Artificial Intelligence and its implications for Business Strategy’, and a MIT certificate on ‘Cybersecurity Leadership for Non-Technical Executives’.

He was notably:

- Head of a consulting mission for S.N.T.F. (Société Nationale des Transports Ferroviaires) in Algiers,
- Interoperability & Standardization Director in SNCF from 2014 to June 2019,
- Expert at OTIF (Intergovernmental Organisation for International Carriage by Rail) in Bern from 2014 to 2019,
- Chairman of CEN-CENELEC Sector Forum Rail from 2016 to 2019,
- COO (SNCF Regional Transportation),
- PMO (SNCF Regional Transportation),
- Head of Paris Gare de Lyon station,
- Infrastructure District manager.

He is today UIC Director of the Railway System, and UIC Africa Coordinator.

Jean-Michel Evanghelou

Jean-Michel Evanghelou is the Director of Telecom, Signalling and Digital Applications, as well as the Director of Financial Controlling and Project Operations of UIC. During his career, he held various positions of Director within Orange Group and joined afterwards Nortel Networks where he had different roles in the international business, serving as Vice-President for various telecom technologies and segments. He has been also serving as Director of the Railway Business Unit of Kapsch Group. Jean-Michel graduated as engineer from the Ecole Centrale of Paris.

Gilbert Reveillon

CEO – Managing Director – Finances, Digital Transformation & eCommerce, Paris – France

- Harvard Business School, FinTech online, Alumni April 2021
- PhD Maître de Conférences (Associate Professor) Institut Mines Telecom - 2013
- Master of Business Administration MBA HEC Montréal (Finances, CAD) – 1991
- Seasoned CEO in High Tech, Aviation, HS Train (Eurostar) & Services (Accor, BNPP)
- CES Las Vegas « Innovation Awards » 2014 & 2015 (Digital Health, Wearable Tech)
- Serial Investor / Business Angel in the digital ecosystem (French Tech)
- JV & Partnerships France, UK, DE, USA (Boston, NYC, Silicon Valley), China (Peking U)

Skills in

- International Business Development for Global Fortune 500 & state of the art startups, including CDO EU Alliances
- Managed for IMT-TEM 350 startups & 30 incubators: Master Program Innovation
- Cross border France-EU-China-UK-USA-CAD investment projects in Innovation and Technology (IoT, Quantum Computing & Q

Sensing, Digital Transformation, AI & MLearning, Industry 4.0, AV & VR, Blockchain & Cryptos, Cybersecurity, IS, FinTech, M&A)

- Seminar & International Keynote Speaker
- Washington DC, NYC, Boston, Shenzhen, Beijing, Shanghai, Wuhan, HKG, Tokyo, Luxemburg, Geneva, London, Paris etc.
- World Bank, IMF, UN, UIC, CES & CES Government (as Chairman Europe), ANDESE, (PhD EU Awards), Club GIS etc.
- CCE (Conseiller du Commerce Extérieur - Foreign Trade Advisor for the French Government), President ICT & Digital Economy

(white paper to DGT & Ministry of Economics & Foreign Affairs and French Parliament)

1. Context

CES (Consumer Electronic Show) Las Vegas is a worldwide annual event regarding the last trends and innovations on electronics, software, artificial intelligence, etc.

The CES Las Vegas 2021 was cancelled because of Covid-19.

The CES Las Vegas 2022 was a hybrid event, with more than 4,400 booths, hybrid conferences, and around 45,000⁸ visitors. China was not present. GAFAM were not present. Nothing was presented on public transport, nor on the railways.

The **CES Las Vegas 2023** hosted more than 3,200 undertakings, including over 1,000 start-ups. 115,000 visitors from 140 countries and 4,800 media attended the event⁹.

CES Las Vegas 2023

UIC¹⁰ has been active at CES Las Vegas and CES Government since 2017, participating in conferences and panels, delivering keynote speeches, and supporting the promotion of rail.

In 2023, UIC increased its presence at CES even further.

For example:

- For the very first time, **UIC had its own booth**. UIC was there to promote and advocate for railway digitalisation, and fostering rail as the backbone of new transport mobility. This was also the reason why **UIC invited two start-ups**, COSLING and CYLUS, which had developed innovative solutions for rail, to join them:
 - COSLING helps companies maximise their response time with optimisation algorithms for planning and configuration¹¹;
 - CYLUS provides rail operators with specialised cybersecurity solutions to ensure service availability and safety. Combining in-depth rail and cybersecurity expertise, CYLUS has pioneered a platform for real-time asset visibility and threat detection across diverse technological rail operating environments. With customers across the globe, CYLUS is a pioneer in comprehensive cybersecurity solutions, enabling compliance and reducing risks in the face of escalating cyber threats¹².

In addition, **UIC** was a **partner of “the CES 2023 Web 3 Tokenization Village”**, and was involved in different activities:

- Jean-Noël Barrot, French Minister for Digital Transition and Telecommunications, visited the Village on 5 January 2023;
- Jean-Michel Evanghelou, Deputy UIC Rail System Director, delivered a keynote speech on “*Digital twins within web 3.0 and industry 4.0*”.

We take this opportunity to warmly thanks Gilbert REVEILLON for hosting UIC in his village, close to other partners, such as French CCE, DAVENSI, ADAN, Creative Valley and many others.

Mobility was one of the key trends for CES Las Vegas 2023. UIC was able to ensure that rail was present and could be considered as a key actor for future green mobility.

UIC intends to be present and even more visible and more active in 2024, in order advocate and promote rail as the backbone of the future mobility for both passengers and goods.

⁸ Les Echos (2023), « *Tech : le CES fait sa (vraie) rentrée après la pandémie* », Online, Available at <https://www.lesechos.fr/tech-medias/hightech/le-ces-fait-sa-vraie-rentree-apres-la-pandemie-1893691> (Accessed 4 January 2023)

⁹ Forbes (2023), « *#CES2023 | Ce que l'on peut retenir du salon de Las Vegas ?* », Online, Available at <https://www.forbes.fr/business/ces2023-i-ce-que-lon-peut-retenir-du-salon-de-las-vegas/#:~:text=Les%20chiffres%20cl%C3%A9s&text=Le%20salon%20s'est%20termin%C3%A9,de%20plus%20de%20140%20pays> (Accessed 11 January 2023)

¹⁰ UIC (2023), “*UIC at CES 2023 in Las Vegas*”, Online, Available at: https://uic.org/com/IMG/pdf/230105_-_uic_at_ces_2023_in_las_vegas_-_press_release_-_uic_rev_final.pdf

¹¹ For further information, see: www.cosling.com

¹² For further information, see: www.cylus.com

2. Main trends

The edition **CES 2023 Las Vegas** was **different**:

- It used to focus on consumer electronics, from large screen TVs to various connected objects. Now, the organisers have developed what they call marketplaces, i.e. fairs that are increasingly BtoB, whereas the fair was originally **much more BtoC**¹³.
- The **automotive sector** confirmed its **leading position** at the show, which was traditionally devoted to consumer electronics. This year, CES 2023 Las Vegas was considered as the world's largest car fair. Automotive sector was devoted to autonomous or electrical vehicles, with a special focus on increasingly connected vehicles ("smartphone on wheels").
- **Microchip manufacturers**, such as Qualcomm and AMD were present, particularly for the automotive sector¹⁴. AMD presented a keynote on its latest innovations.
- **Metaverse** was back in force.
- In addition to the metaverse, an entire hall was dedicated to **Web3**. Web3 "revolves around the idea of decentralization and often incorporate blockchain technologies, such as various cryptocurrencies and non-fungible tokens (NFTs)"¹⁵.
- **Portable batteries and power stations**, for both domestic and industrial usages, are becoming a major trend, allowing their use in a more decentralised and widespread way.

This edition was also different in terms of public transport.

Indeed:

- Autonomous shuttle solutions for public transport were presented (Oxbotica, Zoox, ZF, etc.);
- Railways, through the UIC, were represented for the first time.

2.1. Main trends in 2022

In 2022, the main trends, from a railway sector point of view, were the following:

- Growing contribution of **5G**;
- Increased Cloud Infrastructure;
- Deeper AI Innovations:
 - Natural Language Processing (NLP),
 - Computer Vision,
 - Machine Learning (ML).

With AI Applications on:

- Conversational AI Humans,
 - Autonomous Systems.
- **Metaverse** seemed to become unavoidable.

¹³ Les Echos (2023), « A Las Vegas, le CES accélère son virage vers le BtoB », Online, Available at <https://www.lesechos.fr/start-up/ecosysteme/a-las-vegas-le-ces-accelere-son-virage-vers-le-btob-1894551> (Accessed 6 January 2023)

¹⁴ Les Echos (2023), « Voiture connectée, écran flexible, PS VR2... Les innovations », Online, Available at <https://www.lesechos.fr/tech-medias/hightech/voiture-connectee-ecran-flexible-ps-vr2-les-innovations-incontournables-du-ces-2023-1893812> (Accessed 4 January 2023)

¹⁵ Wikipedia (2023), "Web3", Online, Available at <https://en.wikipedia.org/wiki/Web3> (Accessed 17 March 2023)

➤ The Enterprise Experience:

- Virtual meetings,
- Remote collaboration,
- Immersive Design,
- Simulations / Digital Twins,
- Marketing and Sales.

From a transport point of view, the top trends were:

- Electric Vehicles;
- **Luminar and Lidar**, useful for Automatic Train Operations (**ATO**) and **detection of obstacles** on railway tracks;
- Self Driving trucks;
- Urban Air Mobility.

However, nothing about public transport (except for bikes and freight logistics of the last mile), and nothing on railways.

The other main trends were:

- Space technologies,
- Sustainable technologies, notably **smart cities**,
- and digital health, with a specific focus on **wearables**, which could be useful for **occupational health for railway staff**.

2.2. Main trends in 2023

CES 2023 Tech Trends

Steve Koenig, VP Research of the Consumer Technology Association, opened CES with his “CES 2023 Tech Trends to Watch”¹⁶

Industries are still confronting global challenges:

- Supply chains remain vulnerable,
- Semiconductor demand stubbornly inflation softening,
- Labor shortages,
- Stubborn inflation and rising interest rates.

However, the key technology themes of CES 2023 are:

- Enterprise Tech Innovations,
- Metaverse / Web 3.0,
- Transportation and Mobility,
- Health technology,
- Sustainability,
- Gaming and services.

¹⁶ Consumer Technology Association (2023), “CES 2023 Tech Trends to Watch”, Online, Available at <https://videos.ces.tech/detail/video/6318202282112/ces-2023-tech-trends-to-watch>, (Accessed 4 January 2023)

2.2.1. Enterprise Tech Innovations

This theme covers:

- 5G and industrial IoT applications,
- Connected intelligence,
- Autonomous systems,
- Quantum Computing,

enabling automation and virtualisation.

The digital utilities underpinning the modern enterprises are:

- Cybersecurity,
- Cloud,
- AI & robotics.

In terms of **logistics** and **warehouse automation**, these trends will increase **productivity**, improve **worker safety** and optimise uptime and floor space.

2.2.2. Metaverse

Metaverse is closer than we think.

Metaverse of Things (MoT) will have impacts on:

- **Virtualisation** (virtual spaces, multiple access points, digital twins, individualisation of the consumer experience),
- **Immersion experience** (virtual scenarios, full immersion, VR-based experience, digital twins, shared experience).

The metaverse strategies will range from consumers (retail, competition, entertainment, social interactions) to businesses (simulation, immersive marketing, Metaverse as a Service) and mixed uses (communication, cooperation, transaction).

2.2.3. Transportation and Mobility

This theme covers:

- Electric Vehicles (EVs) and the **evolution of the electrification ecosystem**, covering land, sea and air-transport,
- Advancement of **autonomous systems** and application,
- Transformation of the in-vehicle experience.

The transformation of the in-vehicle experience will be based on:

- Screenification,
- Voice control,
- 5G V2X,
- Retail and entertainment services,
- Features as a Service (FaaS) Models.

2.2.4. Health technology

This theme covers:

- Digital therapeutics, notably new ways to manage chronic health conditions,
- Telehealth,
- Fitness tech.

The new frontiers in Health Tech innovations are:

- On-demand network (24/7 virtual visits):
 - Access to online pharmacies,
 - Remote patient monitoring,
 - Fitness/wellness platforms.
- Mental wellness:
 - Stress relief,
 - Anxiety management,
 - Monitoring depression.
- The virtual reality will be applied to:
 - Fitness,
 - Therapeutic treatments,
 - Physician training.

2.2.5. Sustainability and Environmental and Social Governing (ESG)

Sustainability innovations are based on:

- Smart grid,
- Supply chain,
- Agriculture/Food tech,
- Clean air and water,
- Alternative energy,
- Minimizing packages,
- Recycling technologies,
- Reducing use of rare earth metals.

The farm of the future will be based on:

- Intelligent silos,
- **Drones** and soil detectors,
- Satellite and 5G connections,
- Connected farmers,
- Farming robots,
- Offsite analysis platforms.

2.2.6. Gaming and services

Gaming will be based on the latest technological developments.

In addition, it is important to consider two important keynote speeches:

- Olivier Zipse: Chairman of the Board of Management, BMW: *“How the Future of Mobility Can Merge the Real and Virtual Worlds”*, 4 January 2023¹⁷;
- Carlos Tavares, CEO, Stellantis: *“The Future of Sustainable Mobility”*, 5 January 2023¹⁸.

Of all these main trends, the railway sector should carefully monitor potential transfers to railways: 5G use cases and industrial IoT applications; connected intelligence; autonomous systems; Quantum computing; cybersecurity, Artificial Intelligence (AI); robotics; Metaverse of the Things (MoT); immersion experience; electrification ecosystems; transformation of the in-vehicle experience; smart grids; applications for supply chain; solutions for clean air and water; alternative energies; recycling technologies and drones technologies and applications.

¹⁷ Zipse, Olivier (2023), “How the Future of Mobility Can Merge the Real and Virtual Worlds”, on line available at <https://videos.ces.tech/detail/videos/ces-2023-keynotes/video/6318212504112/bmw-keynote?autoStart=true>

¹⁸ Tavares, Carlos (2023), “The Future of Sustainable Mobility”, Online, Available at <https://videos.ces.tech/detail/videos/ces-2023-keynotes/video/6318254987112/stellantis-keynote?autoStart=true>

3. Innovations which could be applied in railways

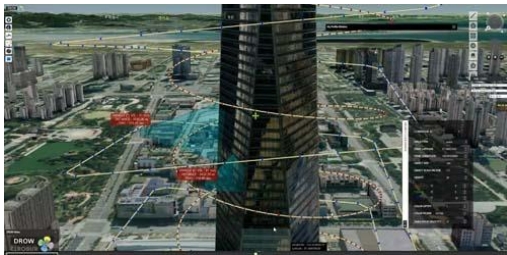
In this respect, we have monitored the best innovations presented at CES Las Vegas 2023, which could be applied to railways.

3.1. Enterprise Tech Innovation



“Drop Free Glass (DFG) is the world’s first electronic self-cleaning technology for optical sensors. DFG can promptly remove various contaminants on the surface of the sensors using an advanced microfluidic technology based on electrowetting-on-dielectric (EWOD) principle. The EWOD-driven DFG has outstanding advantages including fast operation speed (1s), low power consumption (1mW), and high durability (>1,000,000cycles). For the first time, the DFG is applied to AI surveillance cameras for daily life safety and future industries such as smart cities and factories; therefore, DFG-aided outdoor AI surveillance camera can always guarantee clear camera images even during rainfall.”¹⁹

DROW 4D Lapse By CLROBUR



“DROW 4D Lapse is a web-based application where any drone can be autonomize to take photos of objects or buildings for 3D mapping, facility management, or inspection. Instead of manually setting waypoints, the drone’s flight path is automated using AI and a 3D point cloud of the object. We capture 4D data, meaning 3D data plus a timelapse of all previous data to note any changes in the object over time.”²⁰

This innovation might lead to an automatization of the buildings’ inspection, tracks and artworks.

Smart Early Warning System for Predicting Slope Failure By Smart Geotech Co., Ltd.



“A smart measurement system that consists of a rod-shaped displacement sensor, IoT client, and gateway to measure the slope displacement in the vicinity of the slip surface. It is an intelligent sensor-based slope failure early warning system that transmits a real-time warning to the users if the rate of displacement exceeds the standard value set by the algorithm.”²¹

This innovation could be applied to the embankment monitoring along the tracks.

¹⁹ CES 2023 - “DFG aided AI surveillance Camera”, Online, Available at <https://www.ces.tech/innovation-awards/honorees/2023/best-of/dfg-aided-ai-surveillance-camera.aspx>

²⁰ CES 2023 -DROW 4D Lapse by CLROBUR – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/d/drow-4d-lapse.aspx>

²¹ CES 2023 – “Smart Early Warning System for Predicting Slope FailureBy Smart Geotech Co., Ltd.” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/smart-early-warning-system-for-predicting-slope-fa.aspx>

Aloception By Visual Behavior



“Aloception is a visual software sensor addressing mobile robots' full autonomy. Aloception is providing the core components of the scene: navigable area, obstacles & robot localization. Free space & obstacles are provided with descriptors to address final robotics applications. The solution is solely based on cameras & intelligence with the flexibility to run one or multiple cameras and lenses at the same time from various positions.”²²

To be considered for COBOT

Aircore EC By Infinitum



“The Infinitum Aircore EC is disrupting the motor industry with its innovative patented PCB stator and integrated Variable Frequency Drive (VFD). Using lightweight, reusable materials and modular design, Infinitum's motor generates power in half the weight and size, at a fraction of the carbon footprint and noise of traditional motors. With no iron and 66% less copper, the Aircore EC can sustainably power commercial and industrial applications, such as HVAC fans, pumps and materials handling equipment.”²³

Could be of interest to reduce weight of engines in rolling stocks and therefore to increase the performance

GREENTRIC ECO 170kV GIS(GREENTRIC Eco170) By HYUNDAI ELECTRIC & ENERGY SYSTEMS CO., LTD.



“Hyundai Electric & Energy Systems completed the development of a high-voltage circuit breaker (HVCB) for the rating of 170 kV, 50 kA, and 60 Hz using CO₂ and C₄F₇N. The HVCB, part of a Gas Insulated Switchgear (GIS) bay of the same voltage rating, is a three-pole operated in one tank encapsulated design that has fulfilled all the IEC 62271-100 tests. Its performance equals that of SF₆ gas counterpart but shows a more than 99% reduction of the Global Warming Potential (GWP) of the gas mixture.”²⁴

This high-voltage circuit breaker could be of interest for electrical substations and possibly rolling stocks

²² CES 2023 - “Aloception by Visual Behavior” - Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/a/aloception.aspx>

²³ CES 2023 “Aircore EC by Infinitum” - Online – Available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/a/aircore-ec.aspx>

²⁴ CES 2023 - GREENTRIC ECO 170kV GIS(GREENTRIC Eco170) By HYUNDAI ELECTRIC & ENERGY SYSTEMS CO., LTD. – Online available at [https://www.ces.tech/innovation-awards/honorees/2023/honorees/g/greentric-eco-170kv-gis\(greentric-eco170\).aspx](https://www.ces.tech/innovation-awards/honorees/2023/honorees/g/greentric-eco-170kv-gis(greentric-eco170).aspx)

INTEGRICT Industrial Complex Energy Management System By HYUNDAI ELECTRIC & ENERGY SYSTEMS CO., LTD.



“INTEGRICT Industrial CEMS (Complex Energy Management System) is a cloud-based smart energy platform that provides total energy management and energy services for factories in industrial complexes. Unlike the existing Factory Energy Management System (FEMS), CEMS not only analyzes energy consumption by plant, process, and facility of each plant but also performs energy management from the perspective of industrial complexes. Furthermore, it serves as an energy platform and provides various services such as energy trading, facility maintenance service, and RE100 consulting through the participation of third parties in the energy sector.”²⁵

This realization is applicable for the management of large industrial centers

ADTF3175 By Analog Devices, Inc.



“The ADTF3175 module is the industry’s first high-resolution, industrial quality, indirect Time-of-Flight (iToF) module for 3D depth sensing and vision systems, fully calibrated for depth data and ready to image a scene. It enables cameras and sensors to perceive 3D space in one-megapixel (MP) resolution. The module offers highly accurate +/-3mm iToF technology available for machine vision applications ranging from industrial automation to logistics, healthcare, and augmented reality. It provides an image resolution that is double or triple the pixel count of competitive solutions.

More info: <https://www.analog.com/en/products/adtf3175>

ToF System Design Part 1: <https://www.analog.com/en/analog-dialogue/articles/time-of-flight-system-design-part-1-system-overview.html>

Part 2: <https://www.analog.com/en/analog-dialogue/articles/tof-system-design-part-2-optical-design-for-time-of-flight-depth-sensing-cameras.html>²⁶

3.2. Metaverse / Web 3.0

Cybersecurity & Personal Privacy



“DeCloakFace is a trustable AI obfuscated image processing technology for facial recognition, which allows the user to conduct secure identity verification without leaking personal information. DeCloak, the developer of DeCloakFace is a privacy computing company, which aims to make personal data privacy easy and manageable”.²⁷

This innovation will accelerate the access to the trains while improving the respect of the passengers’ personal data.

²⁵ CES 2023 – “INTEGRICT Industrial Complex Energy Management System By HYUNDAI ELECTRIC & ENERGY SYSTEMS CO., LTD.” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/i/integrict-industrial-complex-energy-management-sys.aspx>

²⁶ CES 2023 – “ADTF3175 By Analog Devices, Inc.” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/a/adtf3175.aspx>

²⁷ CES2023 - “DeCloakFace” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/d/decloakface.aspx>

MetatwinBot By BrainBot



“MetatwinBot is a robot that maximizes communication for users with low accessibility to metaverse environments. Its machine vision and visual interaction devices allow users to communicate and engage in a virtual environment without requiring any of the devices used in conventional metaverse environments, such as VR glasses. MetatwinBot was built based on the “digital twin” concept. It executes commands and connects the metaverse to the real world, enabling people in digital blind spots such as the elderly and disabled to communicate with family, friends, medical professionals, and social workers, allowing them to receive vital medical and health care wellness services.”²⁸

To be closely watched for interaction with disabled passengers

Illum transparent antenna for metaverse applications By Sensorview (Yonsei University)



“Glass-type antenna using transparent materials.

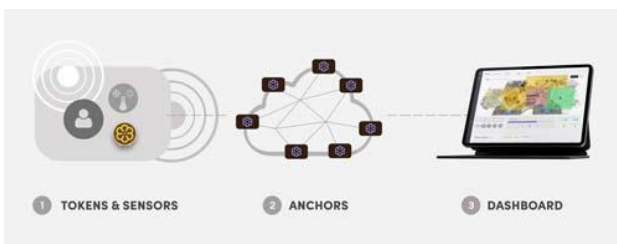
Existing antennas utilize glasses’ frames or separate spaces to implement electronic components and antennas. As a result, it has a low antenna efficiency and difficult to secure coverage.

By implementing the antenna in the glass part of the glasses where information is displayed, it is possible to increase the radiation efficiency of the antenna and secure the coverage.

Additionally, we have secured both manufacturing technology and antenna implementation technology, that can implement both sub6 and WIFI antennas onto the front glass of devices, including AR/VR devices.”²⁹

Could be of interest for stations

TokenMe By TokenMe B.V.



“Most effective Mobile Presence & Task monitoring AI solution solving the patent problem of exceeding project costs of large construction by up to 20% , using proprietary system of task & presence monitoring and wireless environmental sensors, providing realtime logistic & planning information to (sub)-contractors, supervisors and management to monitor actual task execution, location of materials & equipment and realtime presence of personnel, enabling up to 50%

faster build time and 20% lower project cost , simultaneously solving the challenges of global scarcity of skilled labor, substituting scarce materials & employee safety tracking, to better manage operational cost and profitability.”³⁰

²⁸ CES 2023 – “MetatwinBot By BrainBot” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/m/metatwinbot.aspx>

²⁹ CES 2023 - “Illum transparent antenna for metaverse applications By Sensorview (Yonsei University)” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/i/illum-transparent-antenna-for-metaverse-applicatio.aspx>

³⁰ CES 2023 – “TokenMe By TokenMe B.V.” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/t/tokenme.aspx>

PMCAC By GLOphotonics



“Precision-timing atomic-clocks are at the heart of human-activities with vital and ubiquitous significance in multi-trillion-dollar markets like cyber-security, geopositioning, secured 5G telecommunications and quantum sensors. Transcending 20-years of world-leading research in quantum photonics based on its proprietary technology, GLOphotonics unveils Photonic-MicroCell-Atomic-Clock (PMCAC): a compact and shapeable quantum device that unlocks a paradoxical and overdue situation and sets the pace for trillion-dollar market and

multi-paradigmatic changes. PMCAC is designed to bring the historical and unequaled scientific laboratory-atomic-clock performances to the consumer's finger tips”.³¹

Numerous rail applications relies on atomic precision for their accuracy.

Among them, FRMCS to secure 5G communications. It can used to improve geographical positioning...

GLOphotonics
The Hollow-Core PCF & Photonic-MicroCell™ company
Introduces its award winning
PMCAC: PHOTONIC MICROCELL ATOMIC CLOCK

PMCAC PMCAC the *ideal* companion for Satellite-free navigation, positioning, and precision timing

- Backbone for agile quantum sensing
- Superior performance than existing miniature atomic clock
- very small & shapable footprint.
- Compatible with any IT device

GLOphotonics

PMCAC PMCAC the *ideal* companion for Satellite-free navigation, positioning, and precision timing

- Satellite-free navigation & positioning

GLOphotonics

PMCAC PMCAC the *ideal* companion for Satellite-free navigation, positioning, and precision timing

- Enabling NIST-compliant Quantum-Resistant Cryptographic Algorithms

GLOphotonics

PMCAC A proven technology for quantum sensing & information

Features First Gas-photonics component³¹

- Million-fold enhancement in Gas-Light interaction
- Unique microconfinement of gas and atom vapours in optical fiber
- Shapable footprint
- Platform technology

They tested & loved it

- NASA Environmental monitoring
- LOECHEED MARTIN Defense
- ESA Quantum metrology
- Northrop Grumman Space technology

GLOphotonics

PMCAC: PHOTONIC MICROCELL ATOMIC CLOCK

Key Features

- Ultra-low power consumption (<100 mW)
- Shapeable and compact footprint (typical: pen-shaped with a volume of 10x1x1mm³)
- Ultra-small mass (<<50 grs)
- Short term stability 10⁻¹¹-10⁻¹³ at integration time of 1000s.
- Low long term drift.
- Long operating temperature range and harsh environment resistant.

GLOphotonics

³¹ CES 2023 – “PMCAC By GLOphotonics” - Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/pmccac.aspx>

3.3. Transportation and Mobility

Aeries II By Aeva



“It leverages 4D sensor data to deliver new capabilities such as Ultra Resolution, which provides up to 20 times the resolution of legacy.

LiDAR sensors, enabling automated vehicles to detect objects like small road hazards at highway speeds from up to twice the distance of 3D LiDAR sensors.”³²

Technology to be considered for the development of ATO

Eyeonic Vision System By SiLC Technologies



“The Eyeonic Vision System is the first ever commercially available FMCW LiDAR based on a fully integrated silicon photonics chip (The Eyeonic Vision Chip) solution targeted to applications that use machine vision.

The Eyeonic Vision Chip integrates all photonics functions needed to enable a coherent vision sensor, offering a tiny footprint while addressing the need for low-cost and low-power.

An ultra-low linewidth laser, a semiconductor optical amplifier, Germanium detectors, and meters of optical circuits are integrated onto a silicon photonics chip.

The fully integrated solution provides high sensitivity which translates to a LiDAR solution with longer range and better precision.”³³

To be considered for the development of ATO

SF (SuperFast) Battery By SK



“This battery is manufactured by SK On, using Nickel 83% Cathode which is the highest nickel content. With the help of SK On’s fast charging protocol, this battery is charged from 10% to 80% within 18 minutes. Quick charging technology could cause vehicle fires; however, SK On’s has achieved zero number of vehicle fire.”³⁴

³² CES 2023 - AERIES II by “Aeva” – Online Available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/a/aeries-ii.aspx>

³³ CES 2023 “Eyeonic Vision System By SiLC Technologies” Online – Available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/e/eyeonic-vision-system.aspx>

³⁴ CES 2023 “SF (Super Fast) Battery By SK” – Online – Available at [https://www.ces.tech/innovation-awards/honorees/2023/best-of/sf-\(super-fast\)-battery.aspx](https://www.ces.tech/innovation-awards/honorees/2023/best-of/sf-(super-fast)-battery.aspx)

Spatial Touch Automotive By Vtouch, Inc.



“SpatialTouch™ makes it easy and precise to control many in-car functions by simply pointing at them.

It offers a truly touch-like interface for a 3D space. With SpatialTouch™ you can make any real-world objects interactive and you can directly select and control them as well as set them as hyperlink shortcuts.

Single SpatialTouch™ system covers everything in the vehicle, such as the display and buttons, as well as the air vents and sunroof.

A hygienic contactless solution for passengers in taxi and ride-sharing services.

Drivers don't need to look away from the road (just look into peripheral vision or glance).³⁵

Investigate potential application in train driver's cab

Driver Monitoring System With Invisible Camera By Behr-Hella Thermocontrol GmbH (BHTC)



“BHTCs' Driver Monitoring System (DMS) allows for observing the drivers' degree of distraction while driving. It also monitors drivers' awareness like eye openness to detect potential degrees of fatigue. Our Target is to decrease fatal accident rates.”³⁶

Flexible Solid State Electrochromic Thin Film By Ambilight Inc



“Electrochromic (EC) thin films assembled with proprietary EC advanced materials can modulate light and heat transmission rendering properties such as visual comfort and energy savings. The material design and fabrication with solid electrolyte achieve chemically, and electrochemically stable high performance electrochromic devices produced in large scale by cost effective roll-to-roll technique. Thin film-based EC devices can be easily cut and encapsulated into a glass with any curvature and irregular shapes, which makes it possible to be applied into a wide “variety of applications.”³⁷

Could be of interest for buildings (stations and offices) and carriages.

³⁵ CES 2023 - “Spatial Touch Innovation by Vtouch Inc.” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/spatial-touch-automotive.aspx>

³⁶ CES 2023 – “Driver Monitoring System With Invisible Camera By Behr-Hella Thermocontrol GmbH (BHTC)” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/d/driver-monitoring-system-with-invisible-camera.aspx>

³⁷ CES 2023 – “Flexible Solid State Electrochromic Thin Film By Ambilight Inc” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/f/flexible-solid-state-electrochromic-thin-film.aspx>

Incheon Airport (South Korea)³⁸



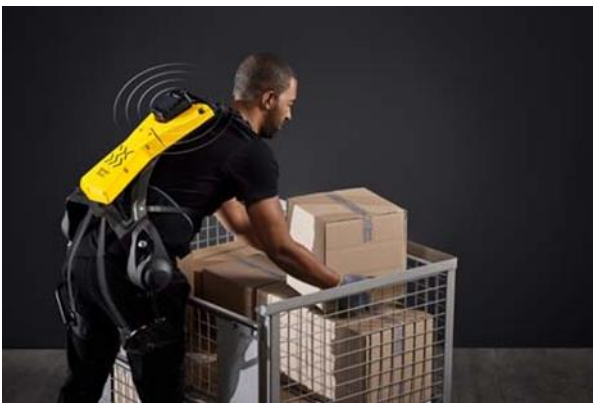
Incheon Airport's booth presented a new paradigm for the airport industry.

- The Smart Pass was described. Starting I 2023, any passenger at Incheon Airport can fly safely and securely with a single biometric ID, without the need for paper documents. Thus, seamless journey with biometric ID will be possible. Indeed, once registered, no additional registration is needed from passenger for 5 years. In addition, a 99.9% accuracy of facial recognition based on deepl learning technology will enhance security.
 - The remote baggage drop-off available at homes and hotels will be facilitated by biometric information. The wait time at the check-in counter will then be minimized. In addition, a smart tracking of luggage will be available on smartphones, based on electronic tags and biometrics.
 - Virtual Incheon Airport is a digital replica of Incheon Airport which allows passengers to explore and experience various virtual interactive contents simply using smartphones.
- Incheon Airport's navigation app. for indoor parking along with innovations in indoor positioning technology provides accurate traffic information and vehicle routes. Thus, it provides the real-time status of parking lots and the location information of an empty parking space. It also provides route information based on optimal path finding and driver's preferences.
 - AR Wayfinding utilizes 3D spatial information and AR technology to enhance the passenger experience. Thus, it is possible to benefit real-time tracking of passenger location based on visual data, allowing personalised guide for passengers.
 - Metaverse and robotic technologies are at the heart of the digitalization of the airport, based on 3D spatial information.
 - A 3D air traffic control has been developed.

3.4. Health technology

Cray X

By German Bionic Systems GmbH



"The Cray X is a fully-connected, powered exoskeleton for use in industrial environments such as in the fields of logistics, production and construction. It protects the lower back area by giving up to 66 lb (30 kg) of support per lifting movement as well as providing active walking assistance to prevent fatigue. The human-machine system thereby combines human intelligence with machine power."³⁹

³⁸ Incheon Airport (2023) – "Incheon Airport – CES 2023 – We Connect Lives, Cultures and the Future", Online- Available at <https://incheonairport-blog.com/?p=840>

³⁹ CES (2023) – "Cray X By German Bionic Systems GmbH" – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/best-of/c/cray-x.aspx>

Autonomous Model A By WHILL, Inc.



“Utilizing advanced mapping technologies combined with the latest in sensors and collision avoidance, Autonomous Model A is designed to significantly change how individuals with limited mobility and reduced sensory or fine motor skills navigate large venues, such as airports, theme parks and hospitals, creating a new era for safe and reliable transportation in crowded areas.”⁴⁰

Ashirase By Ashirase, Inc



“Ashirase is a wearable navigation system that assists the visually impaired with walking. The system consists of a smartphone app and an in-shoe vibration device including a motion sensor. The app receives data from the sensor and puts it together with map and satellite positioning information to generate navigational instructions, which the foot device communicates to the user through vibrations. Ashirase’s intuitive instructions via vibration can guide users to their destinations more safely without obstructing their hearing – a sense that is critical to the visually impaired.”⁴¹

SomaCap™ By Somalytics, Inc.



Made of a nano-infused paper composite, Somalytics carbon-nanotube paper composite (CPC™) capacitive sensor - SomaCap™ - is the world's smallest nano-based capacitive sensor. Miniature and highly sensitive to the human body, they can be used for eye tracking, gesture control, touch and fluid monitoring. SomaCap sensors are designed to improve the human experience through innovations in eye tracking, consumer electronics, AR/VR, the Internet of Things, health and wellness, a transportation.⁴²

Could be applied to Train drivers' surveillance

NightWatch By Nexion Solutions



“As a solution designed to prevent further violence and injury, NightWatch is a GPS-enabled smartwatch that allows its users to access emergency help from specialized operators, who triage crisis events, and then dispatch police or emergency personnel as needed. Through its proprietary platform, operators receive detailed information on the specific case for each victim or witness, which allows for better-informed police response. In addition, an automatic recording of the event provides an additional piece of evidence, which can be used in court to increase the likelihood of a successful conviction.”⁴³

⁴⁰ CES 2023, “WHILL Autonomous Model A”, Online, Available at <https://www.ces.tech/innovation-awards/honorees/2023/best-of/w/whill-autonomous-model-a.aspx>

⁴¹ CES 2023 – “Ashirase by Ashirase Inc.” Online – available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/a/ashirase.aspx>

⁴² CES 2023 – “SomaCap Tm by Somlytics Inc” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/somacap%e2%84%a2.aspx>

⁴³ CES 2023 - “NightWatch By Nexion Solutions” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/n/nightwatch.aspx>

Safee Case By Safee



“Safee is a phone case that conceals an anti aggression device that can be activated in less than 3 seconds and offers up to 5 self-defense features:

1. The user activates the Safee case by pressing the push button 3 times in a row
2. The 130 Decibel alarm presents in the case is activated
3. Start recording with your phone camera and microphone
4. The application sends an alert to the emergency contacts who can follow live cameras, microphones, & position
5. Police are on their way, called by the emergency contacts, with all the information needed”⁴⁴

Smart Wearable Airbag for Professionals C3 By Safeware Inc.



“Designed to protect those working at heights, the wearable airbag automatically inflates within 0.2 seconds in case of an accident, absorbing the fall impact and protecting all crucial body parts such as the head, neck, spine and chest area. Additionally, the airbag is connected through BLE to an accompanied smart phone application, through which an automatic alert is sent and an emergency call is dialed to pre-recorded emergency contacts. This ensures that not only the body is protected during the fall, but that first aid and a timely rescue is guaranteed.”⁴⁵

Of interest for catenaries workers

AirDeep By AirDeep Co., LTD.



“AirDeep, the AI Air Quality Sensor with IoT, analyzes indoor air quality in real-time and detects air pollution state; dust, fine-dust, smoke, abnormal air condition, etc. Furthermore, AI algorithms of AirDeep distinguish smoking types (tobacco or e-cigarette) and recognize abnormal air condition like fire accident in the vehicles and rooms.”⁴⁶

To be considered for air monitoring in the stations, trains and even more for maintenance works in tunnels

Wellness Monitoring & disinfection in public facilities By Xandar Kardian

“The recent pandemic was a wake-up call for paying attention to "wellness" factor when it came to public buildings and facilities around the world. Masks provided a certain level of protection, but unfortunately it was widely politicized, leaving many to be exposed to airborne viruses. Beyond viruses, the world also continued to suffer from increased substance abuse, including Fentanyl in public locations such as bathrooms and elevators. Xandar Kardian has created a radar technology that can discretely, continuously and autonomously monitor the vital signs of occupants in closed spaces for possible rapid deterioration and also help automate disinfection controls.”⁴⁷

Of interest for toilets in stations and in the trains.



⁴⁴ CES 2023 – “Safee Case By Safee” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/safee-case.aspx>

⁴⁵ CES 2023 – “Smart Wearable Airbag for Professionals C3 By Safeware Inc.” Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/smart-wearable-airbag-for-professionals-c3.aspx>

⁴⁶ CES 2023 – “Airdeep” by Airdeep Co. Ltd” – Online available at <https://www.ces.tech/innovation-awards/honorees.aspx>

⁴⁷ CES 2023 – “Wellness Monitoring & disinfection in public facilities By Xandar Kardian” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/w/wellness-monitoring-disinfection-in-public-facilit.aspx>

Motion Pillow 2023
By 10minds Co., Ltd.



“This product consists of a pillow and a drive unit called the Motion System. When the user snores, the Motion System recognizes this and injects air into the airbag built into the pillow. Snoring can be stopped naturally from the user’s head being turned or the cervical spine being lifted due to the inflated airbag or securing the airway by applying a mild level of tension to the muscles around the airway.

This product can prevent snoring even if the user is in a non-supine position. Even if there is another person, it only responds to the user’s snoring sound.”⁴⁸

To be considered for Night trains Premium travel classes

3.5. Sustainability

First green biomass low carbon solvent PnP water filter
By MBRAN FILTRA CO., LTD.



“The green biomass low carbon solvent PnP water filter is an industry-leading product and the lowest carbon emission filter in the world that is unique in its ability to block out bacteria and microplastics.

1. reduce carbon emissions by more than 50~70%;
2. green biomass solvent is an excellent solvent that can be made from sustainable materials (plants or biomass), non-toxic, environmentally friendly, sustainable low-carbon solvent;
3. The water flow rate of the PES (polyethersulfone) hollow fiber hydrophilic membrane PnP water filter is up to 3 L/min, but only weighs 20g. Users can get clean, drinkable water anywhere and anytime.”⁴⁹

Applicable water supply in the trains.

HOPE HydroStation
By HOPE Hydration



“The HydroStation is a cutting-edge bottle refill system offering users free, filtered water and premium drinks like sparkling water or electrolytes, among others.

The WiFi-enabled HydroStation features technology and sensors providing tracking and real-time analysis of water quality, usage, pollution levels and more.

HOPE's HydroStation is the answer to the global search for cutting-edge solutions to eliminate plastic bottle waste.”⁵⁰

Could be considered water supply to clients in the stations

⁴⁸ CES 2023 – “Motion Pillow 2023 By 10minds Co., Ltd.” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/m/motion-pillow-2023.aspx>

⁴⁹ CES 2023 - First green biomass low carbon solvent PnP water filter By MBRAN FILTRA CO., LTD. – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/f/first-green-biomass-low-carbon-solvent-pnp-water-f.aspx>

⁵⁰ CES 2023 – “HOPE HydroStation By HOPE Hydration” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/h/hope-hydrostation.aspx>

EnergyScrum - Energy Management System for DERs

By 60Hertz



“Energy Scrum is an energy management system for distributed energy resources (DERs). It can integrate various DERs, including PV, ESS, fuel cells, and EV chargers, into integrated screens and accurately forecast overall energy supply and demand using AI. Energy Scrum can orchestrate DERs without cumbersome processes and allows users to achieve the goal, such as maximizing eco-friendly electricity use through applying user-specific operation scenarios. For example, EnergyScrum can be applied to an old gas station to transform it into an eco-friendly energy station with DERs.”⁵¹

Climatics and Smartbase

By ACS



“Multi-user data platform Climatics™ is leader in Next Generation Building Intelligence by a unique approach to Building Installation & Property Management through Digital Twin Technology and Machine Learning Algorithms. Our proprietary Smartbase is a powerful gateway to access building Construction & Operations Data, to digitally visualize building installations, integrating them in an easy to use interface and creating fully automatic controls for optimal energy performance, saving a substantial 15 to 40% in energy consumption in both new and existing buildings, as most effective Sustainable and Circular solution for meeting worldwide energy reduction goals requiring minimal deployment of scarce technical personnel.”⁵²

To be considered for real estate Departments.

3.6. Gaming and services

Skinetic

By Actronika



“Skinetic is a haptic vest that allows the user to feel different life-like sensations according to the interactions within the virtual environment.

The Skinetic vest is equipped with 20 highly innovative voice-coil motors all over the torso, this technology allow us to dissociate the intensity from the amplitude of the vibration, thus allowing us to reproduce an infinite range of sensations. The vest also provides localized sensations and can actively track the user position in real time to provide realistic haptic feedback.”⁵³

Not easily transferable but to be considered

⁵¹ CES 2023 – “EnergyScrum - Energy Management System for DERs By 60Hertz” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/e/energyscrum-energy-management-system-for-ders.aspx>

⁵² CES 2023 – “Climatics and Smartbase By ACS” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/c/climatics-and-smartbase.aspx>

⁵³ CES 2023 – “Skinetic by Actronika” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/s/skinetic.aspx>

Hi-Bot (Hologram Image, Guide Robot) By Hills Robotics & KAIST



“Hibot is an AI-based self-driving docent/ guide/ disinfection robot with an advanced hologram feature. The robot can be deployed at various places including convention centers, exhibition centers, hospitals, negative pressure isolation room. The robot is an advanced intelligent universal guide/ docent/ disinfection robot that is useful in the contactless era. It is equipped with a safe disinfection function which can safely stop the spread of coronavirus that is globally transmitting. Moreover, Hibot has a hologram and contactless control function for global remote conference call.”⁵⁴

Potential application in the stations

⁵⁴ CES 2023 – “Hi-Bot (Hologram Image, Guide Robot) By Hills Robotics & KAIST” – Online available at <https://www.ces.tech/innovation-awards/honorees/2023/honorees/h/hi-bot-hologram-image-guide-robot.aspx>

INTERNATIONAL UNION OF RAILWAYS
16, rue Jean Rey - 75015 Paris - France
Tel. +33 (0)1 44 49 20 20
Fax +33 (0)1 44 49 20 29
E-mail: info@uic.org

Published by: UIC Railway System Department
Directors of publication: Francis Bedel, Christian Chavanel
Cover and layout: Ludovic Wattignies
Photo credit: Adobe Stock
Printing: UIC

ISBN 978-2-7461-3277-1
Copyright deposit: April 2023

www.uic.org



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