



The Global Language of Business

Auto-ID Labs Research Projects Summary Report

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The Auto-ID Labs are six of the world's most renowned research institutions. Each of these labs receives funding from GS1 Global Office to support their work. Below are brief summaries of current research projects.

1. Massachusetts Institute of Technology (USA)



Field intelligence with low cost, pervasive RFID sensors research explores pervasive RFID tag-sensing capabilities for emerging Internet of

Things (IoT) applications in precision agriculture, healthcare, civil infrastructure monitoring and cold chain asset monitoring.

Project outcomes may offer GS1 cost-effective RFID sensors with GS1 identifiers that can be detected using commercially available RFID readers. It may provide pervasive sensing capabilities to monitor environmental conditions and more, making them viable for mass scale and commercial deployments.



eyeDNA diagnosis: component failure identification in capital equipment project explores how sensor data can be used to identify faults for capital machines using RFID and sensors (temperature, accelerometers, and gyroscopes).

Leveraging RFID to aggregate sensor data from capital machines, consumer electronics and beyond, illustrates opportunities for GS1 standards in the industrial internet that is predicted to exceed \$15 trillion in market size in the next 15 years.



Bridging the physical/digital divide: enhanced digital visibility research extends image recognition with machine-learning techniques

like deep learning for accurate object identification (products). The project demonstrates how virtually rendered physical objects can power immersive consumer shopping experiences.

Blending the physical and digital shopping experience creates additional opportunities in e-commerce for GS1, enhancing the consumer experience with immersive technologies like augmented reality (AR) and virtual reality (VR).



The **ambient intelligence in IoT home automation** project equips an office with RFID tags to create a 'test bed' to model and demonstrate examples of embedded intelligence (such as environmental changes).

RFID is an enabling technology for creating smart, connected environments. This project presents GS1 with several IoT use cases where RFID capabilities facilitate embedded intelligence, particularly in urban environments.



Cyber security and safety of autonomous vehicles research focuses on the analysis and design of control architecture, detection

mechanisms, and mitigation solutions to cyber attacks on autonomous vehicles.

This project can provide a framework for performing architectural analyses to identify vulnerabilities of sensor networks and mechanisms for planning, mitigating and defending against cyber attacks.

2. Keio University (Japan)



Life cycle information management of digital fabrication products research explores different product information life cycle management

architectures for personal digital fabrication to revolutionise product design and manufacturing practices of 3D printed products.

This project showcases the effectiveness of the GS1 EPCglobal architecture, GS1 unique identifiers and blockchain technology concepts, applied to product information sharing in the era of personal digital fabrication.



Multi-code filtering and collection platform

research focuses on the interoperability of tag encoding formats across both ISO/IEC, GS1 EPCglobal and other RFID encoding schemes, for the filtering and collection of multiple codes.

Multi-code filtering and collection is beneficial to both GS1 and ISO/IEC since it supports mixed-use cases. This could be useful for both manufacturers and logistics providers as it mitigates the logistics cost by enabling a shared transportation, tag-agnostic format.



Accessible automatic identification research

examines ways to improve accessibility of symbols by a visually impaired person. Options include tangible identification such as embossing, simple Braille or notched barcodes, to image recognition and machine and deep learning.

Implications extend beyond the visually impaired to facilitate methods for the remote localisation of symbols, enabling the automatic collection of symbols by machines in warehouses and more.

3. ETH Zurich/University of St. Gallen (Switzerland)



Mobile self-checkout: novel solution for fast-paced convenience retail study includes a

'scan-n-go' smartphone app developed for use at convenience kiosks in Swiss commuter stations. By studying a real-life mobile self-checkout implementation, the researchers are gaining insights into consumer shopping behaviour, loyalty and self-checkout processes.

In addition to educating the GS1 community, the study could motivate retailers to jump into the mobile age of loyalty, self-checkout, and physical retail data analytics.



Proximity-based services: product-related services and VR and AR research uses immersive technologies like VR and AR to make everyday products “smart” and enable next generation digital service offerings for physical products. Using machine learning and analysis of mobile user data, research explores a model to more accurately predict consumer personality traits and shopping behaviour, opening new possibilities to improve marketing effectiveness of products and services.

AR and VR opens new opportunities for enabling GS1 identification and trusted source product data for consumer 3D environments, extending the value of GS1 standards beyond the point-of-sale.



Reality mining on smartphones: mobile personalisation and secure data sharing research explores blockchain technology for sharing personal data sharing and mining mobile app usage data for reality prediction of life stages and life events. It explores how e-commerce recommender systems can provide more relevant personalisation of content.

Research will provide crucial insights on the use of blockchain technology for retail e-commerce and the secure sharing of consumer profile data.



The **mobile health: food literacy and healthy nutrition** project showcases two smartphone apps: “Swiss SaltTracker” and “FoodQuiz”. The project leverages digital nutritional labels combined with digital receipts and a machine-learning model to provide an easy-to-use interface for measuring, monitoring and improving personal food literacy and nutrition.

This project highlights an opportunity for GS1 to improve health on a global scale, and proposes a unique idea for a GS1 standard - an “Allergy Compatibility Number” for allergy identification.

4. Fudan University (China)



Identification of item and location based on wide area network research focuses on designing a low power, low-cost transceiver for narrow-band IoT applications. The research explores solutions designed to realise item identification and location identification based on the wide area network.

This research could lead to a radio frequency standard for applications that require a communication range up to 1000 metres, such as transportation management, warehouse management and parking management, which is not possible with conventional UHF RFID.



Speed measurement of fast-moving tags based on high sensitivity RFID reader research explores a commercially viable and cost effective solution to read fast-moving tags with speed measurement for potential applications of sport, vehicle identification, electronic toll collection systems and more.

This research has the potential to widen the application of conventional RFID system and GS1 identification keys in the field of fast-moving things.



GS1-enabled tracking and tracing system for food safety in China is a national project that provides a standard and trusted data service for food producers and supply chain stakeholders for food safety in China. It provides an IoT trusted service that delivers authentication for the e-pedigree of food, preventing the unauthorised manipulation of enterprise data.

This project demonstrates an IoT system based on GS1 keys, EPCIS and Object Name Service with a potential future application of blockchain technology for data integrity.



Wireless multi-channel neural recording system research includes wireless technologies that explore the neural recording of bio signals from the human body, enabling the study of the active neural system in humans. By expanding our knowledge of the brain and nervous system, this opens opportunities for new treatments of neural diseases like epilepsy and also enables applications such as Brain Machine Interface in the treatment of paralysis.

Brain Machine Interface systems are unique systems that may lead to new communication standards development in order to provide interoperability with other devices and systems.

5. University of Cambridge (UK)



An intelligent product demonstrator for after-sales service project studies the collection of product intelligence for diagnosing the repair of domestic appliances. Demonstrations feature Raspberry Pi-enabled 3D printing in a distributed manufacturing network, a mobile app for interfacing with intelligent products and the use of blockchain technology for dynamic creation and management of 3D-printed spare parts in the supply chain.

This research demonstrates the interaction of mobile, blockchain, 3D printing, and GS1 Auto-ID technologies with intelligent products, end users and companies in a consumer environment.



Flexible and customised logistics in an omni-channel environment leverages product intelligence in logistics to offer custom and flexible solutions to enhance overall customer satisfaction.

Customers require more convenient logistics services when placing orders online. This work will help GS1 better understand the way logistics systems are changing in order to improve the customer experience in an omni-channel environment.



The **Product intelligence in the physical internet** project examines the role of intelligent products in the Physical Internet initiative. The Physical Internet paradigm aims to use the digital internet as a metaphor for the physical world, in order to improve the efficiency of logistics systems and create a sustainable environment.

The Physical Internet paradigm reflects the future of logistics operations in Europe, and as such, GS1 has an active interest in this initiative.

6. Korea Advanced Institute of Science and Technology (South Korea)



Open Language for Internet of Things (OLIoT) EPCIS and discovery service research extends the existing OLIOT platform, provides open source EPCIS and discovery service to find EPCIS, and explores how the EPCglobal system can be extended to develop a scalable IoT platform.

This research is an example for how the GS1 system of standards could be used as a future integration and data-sharing platform to support the IoT. It extends EPCIS with additional lightweight messaging formats in JSON and BSON and provides important security and performance considerations for a discovery service.



GUARDIAN (GUARD International Agriculture Network) project extends the OLIOT platform and leverages cloud technology to provide applications for balanced production, transparent distribution and the safe consumption of agricultural and livestock products.

The project demonstrates the integration of EPCIS with cloud technology to provide innovative applications for the agri-livestock industry.



Smart city: open data-based smart city platform using GS1 architecture research proposes an architecture and design for a GS1 standards based, smart city platform that captures data from various sources, stores it in EPCIS and makes data available to citizens via simple APIs.

GS1 standards can provide the basic building blocks to enable open data-based, smart city platforms. With prototype implementations in Busan city and nine Korean airports, this research highlights the value creation and service enhancement potential of the GS1 system of standards.



OLIoT healthcare services project extends the OLIOT platform and leverages artificial intelligence in the development of a healthcare service that stores, shares and analyses personal healthcare data, collected from healthcare devices, personal electric health records (PHR/EHR), insurance data, and other sources.

Leveraging GS1 unique identification, this project provides a total health data schema for personal healthcare, making it possible to share health data globally between different countries and organisations.



OLIoT traceability project extends the OLIOT platform and implements a traceability network architecture based on a distributed EPCIS system, enabled by a discovery service to connect to a partner EPCIS instance.

This project will provide valuable insights to enable global traceability (GTS2) using a distributed EPCIS architecture.

For questions about the GS1 Auto-ID Labs programme and access to the full Auto-ID Labs Year in Summary reports, contact **Dipan Anarkat**, Director of Industry Engagement EPC/RFID, at dipan.anarkat@gs1.org.



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