An Introduction to Interoperability Standards for Education Leaders

Strategically Connecting the K-12 Enterprise

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Why Do Interoperability Standards Matter in K-12?

With the explosive growth of digital resources to support both instruction and business decision making, more K-12 staff know how to use technology — and value the use of data to inform practice. Yet many express concern that they are "data rich and information poor," which makes integrating, analyzing, and applying data a key challenge. Educational leaders who can harness the growing data generated in their districts can be empowered to transform both instructional and business practices.

Digital classroom tools that collect information and engage students are increasing exponentially. Enterprise data systems such as Learning Management, Student Information, Assessment, and Data Visualization Tools—along with a host of various content tools—need to align in an integrated system to support district goals and improve student outcomes.

> "Forget about goals and focus on the systems instead."
>
> James Clear, Atomic Habits

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The Positive Impact of Interoperability

Interoperability is the capacity of different technologies and educational systems (Student Information, Enterprise Resource Planning, Learning Management) to work together securely and seamlessly to exchange data effectively. Interoperability promises to transform teaching and learning by giving teachers, learners, and administrators more access and control. The benefits of interoperability on day-to-day school district operations and data-based decisions is increasing; districts who find ways to harness this power can better serve their students.

Education decision makers must lead efforts to select products that not only meet their immediate teaching, learning, and administrative needs, but support standards-based data integration as a technical requirement. Products developed with proprietary methods "don't play well with others," and can cause more harm than good if data can't be shared easily between systems.

The growing demand for sophisticated analytics, accountability reporting, and performance management tools requires data exchange between systems. Districts seek to build tools that use content and data assets strategically across a number of systems, and assemble solutions that enable staff to make data more meaningful and understandable.

Interoperability Success Story: Santa Fe Public Schools

The real strength of interoperability might come from combining non-instructional systems data with instructional resources.

The Santa Fe Public School system in New Mexico combined network connectivity data with student information data to accurately identify internet access and speed for every student. The data was then converted to a district map, allowing staff to identify resources that were personalized to the student for improving home access to instructional resources. The data also gave district leaders insight into which applications, devices, and resources were used, along with students' frequency using online resources. This improved the district's ability to better serve students and understand challenges.

Adopting Data Standards

Education has been slow to adopt a set of rules and guidelines for structuring, organizing, and formatting data. School districts that lack agreed-upon data standards often have to purchase applications that might not easily share data. End result: school systems end up over-customizing their data systems to the point that sharing data between systems is very difficult.

Challenges

School district staff are spending an enormous amount of time on data. Cleaning up inaccurate data erodes trust and confidence among staff, parents, and community members. Dissatisfaction runs high in district leaders regarding the amount of time needed to generate reports that are essential for making data-informed decisions.

Compounding the problem: staff often create ad hoc, standalone tools to wrangle data from disparate systems. Such tools are difficult to maintain and scale, especially with high staff turnover. When the tool's creator leaves the organization, their knowledge of the tool often leaves with them. These ad hoc tools also are highly susceptible to misreporting data—particularly if standards and the "source of truth" system are not clearly defined.

In the last few years, parents from school districts across the country have voiced concerns about the multiple logins/applications required to access content, assignments, assessments, and other academic resources. Common pain points:

*Why can't our children have **seamless access to multiple resources**, covering the same content and targeted to that student's current level of understanding?*

*Why can't students have **real-time dashboards** that show what they have accomplished and what they have yet to master?*

*Why can't **teachers have accurate class data** to accurately plan for instruction and intervention?*

*Why can't **principals have data available** to improve their instructional decision making?*

A Path to Solutions

The answer lies in **interoperability**. Going forward, districts will need to develop plans that include the adoption of interoperability standards across the enterprise (business systems, operational systems, instructional systems), to ensure that data can be shared between different systems. This will improve communication and data accuracy while also reducing costs. These standards define the structure and format of educational data (such as student demographics, assessment results, and course information) to ensure that the data can be shared and used in a consistent, meaningful way across the education system.

Three Key Areas of Interoperability Standards

The non-profit organization Project Unicorn published a glossary of 45 different **K-12 interoperability standards**. Education leaders don't need fluency in all of these, but they do need to understand their functions. To navigate the landscape, education leaders should become familiar with the standards and terms impacting these key areas:

1 Digital Learning Resources   **2** Learning Data Exchange and Outcomes   **3** Identity Management: Authentication and Authorization

1 Digital Learning Resources

Digital learning environments require high levels of interoperability between digital learning resources, applications, and the networked computing infrastructure of an educational enterprise. Thus, educational resources increasingly are developed with the presumption that they will be integrated into multiple enterprise service environments that include both new and legacy content/systems.

It is critical for students, teachers, and IT staff—as well as publishers creating digital content and applications suppliers—that districts attain the highest level of integration. Students and teachers benefit from the availability and seamless integration of resources and data to inform learning. IT staff benefit from new access, and from authentication solutions that ensure users can access their resources (and that their data is safe).

Digital Learning Resource standards facilitate the development of an interoperable environment and reduce efforts to integrate or replace content in learning environments. The 1EdTech™ Consortium has developed three of the main standards for learning resources interoperability:

Common Cartridge® /Thin Common Cartridge® (CC/TCC®)

This resource provides a standard way to port digital content for use from one system to another.

Learning Tools Interoperability® (LTI®)

LTI's goal is to ease educators' and students' access to a wide range of educational technology tools and resources, ensuring that these tools work seamlessly within the context of their Learning Management System (LMS.) By providing a standard way for these tools to communicate and exchange data, LTI makes it easier for educators and students to use the tools they need.

Question and Test Interoperability® (QTI®)

QTI is a technical standard for creating, delivering, and exchanging electronic assessments. This provides educators and students a more seamless experience when creating, delivering, and taking assessments in different LMSs.

SCORM (Sharable Content Object Reference Model)

Developed by the U.S. Department of Defense, SCORM is a standard for preparing learning materials so they can be shared across any system using the SCORM standard.

2 Learning Data Exchange and Outcomes

The main objective of data connectivity standards is to provide universal connectivity to data sources from a variety of platforms, using a standard set of commands to transfer data efficiently and cost-effectively. Data connectivity is essential for mission-critical applications including enterprise resource planning (ERP), student information systems (SIS), learning management systems (LMS), and data warehouse applications.

These systems have zero tolerance for delays or errors in accessing, processing, and storing data. Unreliable data connectivity design can lead to poor performance, availability, and scalability, and to data integrity issues that directly impact cost and risk for districts.

CoSN's Cost Calculator tools can help you estimate the cost of the LACK of interoperability on your district's budget. For insights into statewide impact, take a look at the Michigan study that found those costs totaled $163,000,000 per year.

Data Integration

Since district systems have owners throughout the organization, district leaders must understand how data is stored and integrated in order to provide direction to their teams. District IT environments have become more complex, and educational institutions have become more reliant on data as a cornerstone to decision-making processes. This is driving the need for more reliable and timely integration of data across the enterprise—critical for increasing productivity, improving business efficiencies, and reducing costs.

Data integration includes data translation, standard data output format, and other transformation services to make the data usable by each application. Data integration involves combining data residing in different sources and providing users with a unified view of these data.

Data Storage Repositories

Data storage repositories access, analyze, and combine data from disparate systems. Some common types used in education are data warehouses, data lakes, and operational data stores, all of which have different purposes.

A **data lake** stores large amounts of raw data in its original format. Much like a real lake, which stores large amounts of water from multiple sources, a data lake does the same for storing data. Because the data is in its original form, it is easier for data scientists, analysts, and engineers to use.

Data warehouses store large amounts of data which is structured and organized for specific purposes (unlike the data in a data lake). Data warehouses can give decision-makers insight—often called Business Intelligence (BI)—to improve academic and business outcomes. Data warehouses typically capture historical data that can be used for trend analysis and long-term planning.

An **operational data store** (ODS) also combines data from various sources, but is used for day-to-day business operations. Similar to a data lake, an operational data store typically stores data in its original format. The ODS supports near real-time processing for operational use and provides a more comprehensive use of data. An ODS is used with data warehouses and provides a "staging area" before the data is moved. An ODS also might be used to monitor student progress and identify areas of additional support.

Each of these systems can present challenges, especially if data quality in the primary transactional system (LMS, SIS, ERP) is poor—otherwise known as "garbage in, garbage out."

Data Structures

One challenge of data integration is that different platforms use different data structures, which need to be linked through the use of various database solutions and computer languages. Many school systems lack the capacity (in the form of data scientists and engineers) to design an appropriate data structure—which leads to challenging implementation and disappointing outcomes from these systems. Data integration challenges increase along with the volume and the need to share existing data.

To address this problem, integration specifications and standards have emerged to define how systems manage the exchange of information. These data integration models standardize and organize data in a broad range of systems so it can be easily stored in data repositories and served through dashboards. Standards-aligned data **reduces costs and effort** when integrating solutions from different vendors, and enables districts to continually select the solutions they want.

Data Integration Standards and Tools

Developed by the U.S. Department of Education, **Common Education Data Standards (CEDS)** are data standards for a key set of education data elements. Their purpose is to streamline the exchange, comparison, and understanding of data within and across P-20W (early learning through postsecondary and workforce) institutions. The use of CEDS is voluntary, but wide adoption will increase data interoperability, portability, and comparability across states, districts, and higher-education organizations.

Developed by the non-profit Ed-Fi Alliance, the **Ed-Fi Data Standard** is a set of rules for the collection, management, and organization of educational data that allows multiple systems to share their information seamlessly. Closely aligned with CEDS, the Ed-Fi Data Standard is powered by Ed-Fi Implementation Suite—a set of standards-based technology components that includes an operational data store (ODS) for integrating secure real-time data from other systems; an application programming interface (API) to easily exchange data between systems; a dashboard; and development tools that help technology leaders implement these components .

School Interoperability Framework (SIF) specification is an open data standard specifically designed for K–12 education. The SIF specification enables systems such as libraries and student information and transportation systems to interact and share data.

Data Exchange

Manual Data Exchange

Traditionally, data exchange with legacy systems is a very complex process. The process relies heavily on selecting the right file format, appropriate to the type of data and data normalization, transformation, and integration processes. This requires district IT staff and vendors to invest significant time and resources to build a comprehensive process using file transfers. The process typically results in a highly customized solution that the vendor can't replicate easily for other customers, making manual data exchange a costly endeavor.

Application Programming Interfaces (API)

When we plug an electronic device into the wall socket, the device gets energy regardless of the device type or manufacturer. Ideally we would create this kind of "plug-and-play" interoperability environment—in which applications from multiple vendors can exchange information automatically and without customization—but are not there yet. Our situation is analogous to Americans who need adapters to plug their electronic devices into electrical sockets in the UK: systems that aren't designed to work together can still use application programming interfaces, or APIs.

APIs are a set of tools, programs, routines, and protocols for integrating applications. Think of an API as a waiter in a restaurant: when you place an order, the waiter takes it, passes it on to the kitchen, and then delivers the finished meal back to you. An API communicates your requests to a system that can fulfill them and then responds with what you asked for.

3 Identity Management: Authentication & Authorization

Poorly implemented or maintained Identity management processes are a key vector used by cyber criminals to attack school districts' data environments. Identity Management helps control who can access what information within an organization, and ensures that sensitive information is protected and only available to the right people. This includes:

- managing the process of creating and deleting user accounts
- setting up and managing passwords
- assigning and revoking permissions for different systems and applications.

The goal of identity management is to ensure the security of information and systems, while making it easy for people to access the resources they need to do their jobs.

Authentication is the process of verifying the identity of a user, typically through a username or ID, password, smart card, fingerprint, facial recognition or other means. It answers the question of "who are you?"

Due to increased attacks, cyber insurance companies are requiring much more robust authentication processes such as **two-factor (2FA) and multi-factor authentication (MFA)**. Multi-factor authentication is a multi-step account login process that requires users to enter more information than just a password. A second form of authentication is required. For example, a user may need to provide a code that is sent to an email address or text, or have to answer "secret" questions.

Single sign-on (SSO) is an authentication process that allows students and teachers to access multiple resources and applications with just one set of login credentials. This makes it easier and more convenient to access the resources they need, without having to remember different usernames and passwords for each one.

In K-12 education environments, SSO can be particularly important—especially with all the new applications that staff and educators need to access. Some of the benefits of SSO are:

- Streamlined access to educational resources: With SSO, students and teachers can access their learning resources and applications more quickly, without having to waste time logging in to each one separately.
- Improved security: By reducing the number of login credentials that need to be managed, SSO can help to improve security and reduce the risk of unauthorized access to sensitive information.
- Enhanced learning experience: With SSO, students and teachers can focus on their learning goals, without the disruption of constantly logging in and out of different applications.

Authorization is the process through which the system determines whether an authenticated user is allowed access to a particular resource such as a file, system, or application. (For example, teachers should be permitted to enter grades for only their students, but should not have access to district financial records.) Often permissions are based on one's role within the organization. In the K-12 world, this is generally accomplished by feeding user demographic data from human resources and/or student information systems to the identity management system. Additional information is derived from user demographics to determine authorization to various systems.

Rostering is a good example of authorization. Rosters are used to enroll large groups of students into software solutions and create their IDs and passwords. Without rostering, teachers would have to enter students individually into each application they use. This is too cumbersome to do manually and needs to be automated.

Rosters associate students and a teacher with a specific class, section, or program and associate the teacher with each group of students. Rosters can be used to manage digital access of groups of students by giving them access privileges to specific content and tools. They are also used for setting up student accounts for third-party applications.

These third-party applications traditionally have been written with proprietary rostering formats. As a result, teachers or the IT organization have been forced to create a separate roster for each program purchased. This usually involves translating rosters from the school's internal format to many different proprietary formats. When there is a roster change, the updates typically have been done manually for each third-party offering.

Rostering standards make it possible to readily automate the creation and sharing of rosters with third parties that support that standard. Schools and districts can maintain their rosters in any format, then automate the translation to a rostering standard. When a change happens, the roster only needs to be updated once, then propagated to all third parties.

Rostering Data Standards and Tools

xPress Roster®
This resource is a quick and simple SIF-based standard to develop a rostering API that aligns with SIF.
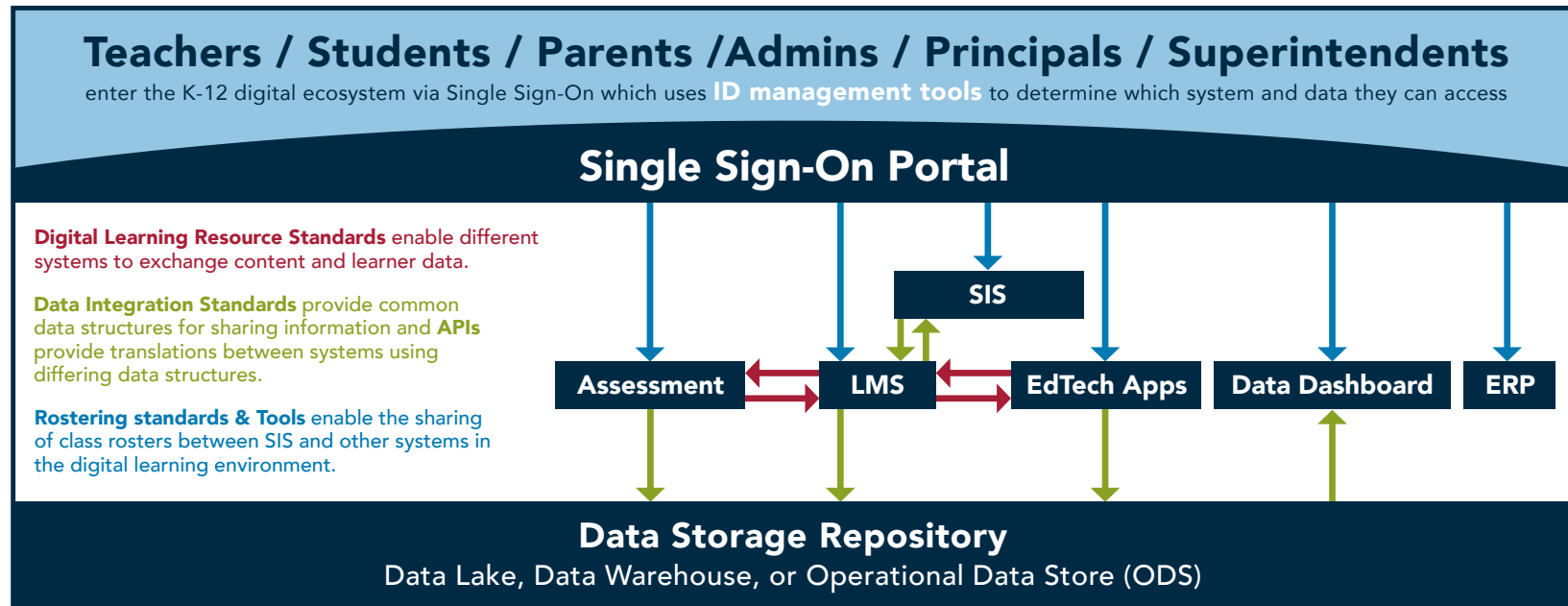
OneRoster®
OneRoster, developed by the 1EdTech™ Consortium, is an enrollment and provisioning standard that ensures that the correct student and teacher are assigned to the correct class and section and have authorized access to the correct content.

File Sharing

File sharing is one of the earliest forms of electronic data and information exchange. Files are shared via the network, emails, or flash drives. Files of all kinds are downloaded via the cloud or from an internet website. Today, there are a number of file-sharing functions built into modern productivity suites like Google® and Microsoft® Teams.

The challenge for school districts is to standardize which platform the enterprise will use. Many if not most districts maintain multiple file-sharing tools, including local standalone file-sharing servers at schools and in departments, along with multiple cloud-based productivity suites. This creates complexity in sharing data, communicating and locating files, extra cost in maintaining licensing and equipment, and increased technical support.

Teachers / Students / Parents /Admins / Principals / Superintendents

enter the K-12 digital ecosystem via Single Sign-On which uses **ID management tools** to determine which system and data they can access

Single Sign-On Portal

Digital Learning Resource Standards enable different systems to exchange content and learner data.

Data Integration Standards provide common data structures for sharing information and **APIs** provide translations between systems using differing data structures.

Rostering standards & Tools enable the sharing of class rosters between SIS and other systems in the digital learning environment.

SIS

Assessment	LMS	EdTech Apps	Data Dashboard	ERP

Data Storage Repository
Data Lake, Data Warehouse, or Operational Data Store (ODS)

Interoperability Governance

Governance is the formalized process for achieving effective interoperability. Governance helps to manage the organizational culture change and potential resistance that can lead to the failure of initiatives. It establishes clear roles and responsibilities, accountability, enforcement, and (most importantly) metrics that measure impact, value, and opportunities for improvement.

Effective governance requires aligning with the district culture and fostering a decision-making culture of collaboration, trust, accountability, and stability. Adopting a clear governance model for data systems can be complex and challenging—particularly if the change is forced on the organization too quickly and/or becomes overly complex and bureaucratized.

Getting Started

To ensure data systems work well together, leadership at the outset needs to ensure departments establish expectations and facilitate conditions to work more collaboratively. Districts that succeed will move from siloed department structures and hierarchical organization configurations to cross-functional teams. A **data governance committee**, comprising key stakeholders as leaders and others with insights toward interoperability, is an excellent approach to navigating territorial issues.

To develop a cross-functional interoperability governance team:

- Start small and build confidence through success
- Identify specifically what high-level problem/s the cross-functional team needs to solve
- Invite and engage members who are most impacted by the problem and find common ground on potential solutions
- Develop a charter document that defines what authority the team has, what evidence will be collected, and how the team will report progress

The cross-functional interoperability governance team might have to make some tough decisions enforced through procurement—especially when content providers push back about keeping their own proprietary systems. Forward-thinking district leadership will recognize that the question isn't *if* they should adopt interoperability, but *when* they will take the steps necessary to ensure safe and secure digital environments for staff and students.

Next Steps

There is no one-size-fits-all approach to standardization. The development of robust, reliable industry standards is a complex and time-intensive process involving costs as well as benefits. How do you know when a set of interoperability standards is worth adopting?

1. **Determine how well the standard meets your needs.** Will adopting it enable a critical user activity or high-priority enterprise capability? Will it lower costs, shorten development time, or facilitate the maintenance and evolution of crucial systems? If the need is there, then carefully researching the different options to invest in products and approaches that support a chosen standard will be well worth the time.

2. **Base decisions on a realistic assessment of the maturity and empirical support for any standard.**
The more mature the approach or standard, the more likely it will have support in the form of a community of practitioners, available documentation, examples, training, and a pool of skilled staff members. Conversely, a newer standard may be supported by enthusiastic pioneers and offer professional development and collaboration opportunities that compensate for the lack of industry maturity.

3. **Gather information on your current state and define the problem statement.**
With the rising importance of cloud computing, Internet-of-Things (IoT), Artificial Intelligence (AI), online learning, portals, modularity, data warehousing, and performance management, interoperability standards have become more crucial than ever. What challenges does your district face with data, reporting, systems alignment, siloed departments? And what is the recommendation to move forward?

4. **Build a cross-functional team of key department leads and system owners.**
The team's role is to prioritize the challenges identified in the problem statement, coordinate priorities, provide oversight, and resolve conflict to ensure resources are allocated to sustain improvement in alignment with the district's goals. The team leader should have a broad understanding of the district's data systems, skills in facilitating successful groups, and a mandate from the superintendent and cabinet for the team to move interoperability forward.

The cross-functional team must reflect and support the culture of the organization as systems move toward transformation.
The biggest downfall of initial efforts will be stifling progress with complexity. It is key to start with a well-defined problem and develop a clear picture of the future state, with metrics that provide evidence of the transformation.
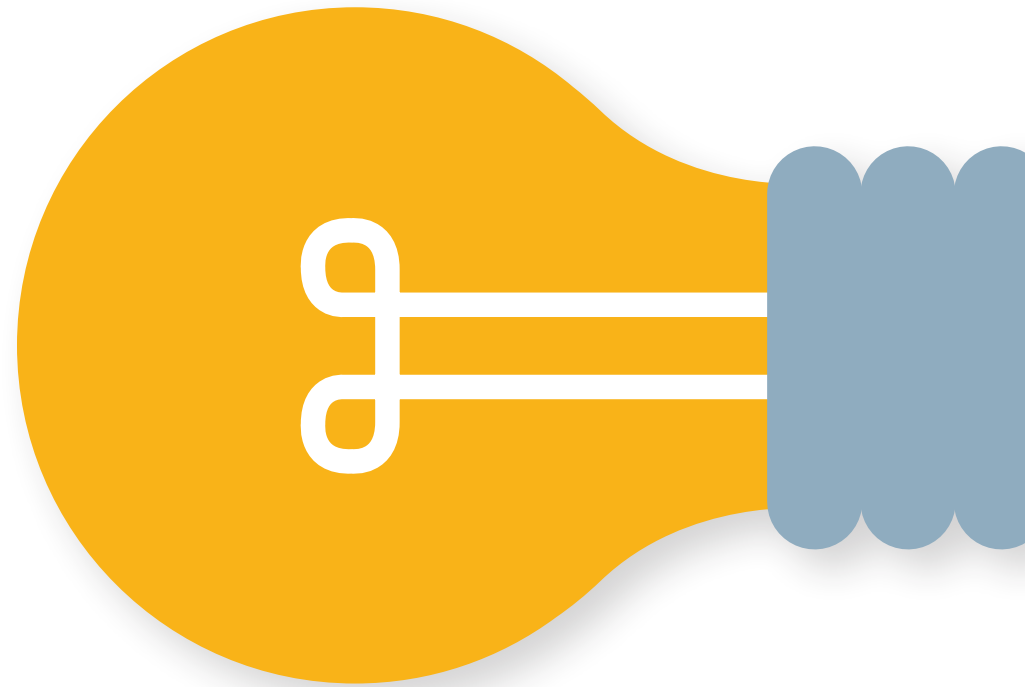
Conclusion

Interoperability is about the intentional decisions made to create an enterprise that allow for the seamless sharing of data and services among systems and applications. Educational leaders need to focus on the systems and processes that lead to the outcome goals for the district. Each system in the district either contributes to the betterment of the entire organization, or it becomes an impediment to its ability to reach district goals. As the IT world shifts from a product-oriented to a service-oriented model and schools struggle to make ends meet, it is essential for K-12 education leaders to maximize the benefits of existing enterprise systems while adding new solutions that are cost-effective and scalable. None of this is possible without interoperability.

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