MTA Genius Transit Challenge

Improving Operations Efficiency & Customer Communications

Introducing TRANSIS:

An Advanced Transit Information Ecosystem

A platform for rapid deployment, refurbishment, and information efficiency in the MTA transit system

Unifying New and Legacy Subway Car Information Technologies

A. APPLICANT INFORMATION

Name of Applicant:	**CSINTRANS Inc. ("CSiT")**
Application Title	**Improving Operations Efficiency & Customer Communications**

B. EXECUTIVE SUMMARY

Traditionally, **faster delivery** entailed rapid assembly and production of steel, nuts, bolts, engine, chassis, and all parts making up the physical car. Rail cars have been designed to last approximately 40 years. From a mechanical perspective, this design cycle holds mostly true. But on-board information technology and communications systems have been introduced in the last 20 to 30 years and have gradually become constrained by the technology refresh cycle that is becoming increasingly short. It is not uncommon today to have communications technology on-board trains becoming obsolete before rail cars go into service. The approach to bridging this design and operations cycle disparity has become a major issue for operators around the world.

Today, the overall rail car delivery is a system integration task that includes not only the physical but also the information and technology aspects that come together as a whole. Modern communications are about the information cloud and ecosystem that follows the subway car out into service and serves as a gateway for increased operational efficiency and **a means to keep the riders informed during their journey and workforce armed with system intelligence for increased efficiency.**

For the past 5 years, CSiT has been developing and implementing transit systems in New York and Caracas, a new modern communications platform to address this and other important transit issues. This platform is called **TRANSIS**, and it includes a suite of products that cover not only the trains, but also the other various modes of transit. The CSiT proposal for the use of the TRANSIS platform at NYCT will improve the operational efficiency and customer communications systems of the MTA's transit system, and will do so in an evolutionary way providing near-term and long-term benefits without disrupting normal transit operations.

With the implementation of the TRANSIS platform, the MTA will have in hand a Corporate Communications platform that will be potentially able to span the entire rail car fleet, buses, stations, kiosks and extend to a mobile environment. At the same time, it will be able to have access to maintenance information of its rail car fleet sub-systems to be able to more efficiently manage its fleet, including being able to help reduce the number of disruptions caused by the number one problem of train door systems malfunctioning.

While providing extensive operational benefits, **the proposed approach enables the MTA to reduce its costs associated to maintenance** by being able to access meaningful homogenized information more quickly and being able to make better decisions regarding maintenance, increasing operational availability of the fleet by now being able to have access to information regarding the status of the rail car at the sub-system level on an operational dashboard at a Control Center.

TRANSIS, as an information integration and management platform, breaks away from the traditional mold of passenger information and reinvents the domain as a multimodal transit information system. TRANSIS connects to open and/or proprietary data sources and transforms the data into homogeneous and consistent information. It takes raw data and aggregates, validates, and stores the resulting information in a generic contextualized persistent information store modelled after industry references, thus facilitating connectivity to other standardized and open transit systems. TRANSIS creates an information ecosystem that integrates heterogeneous inputs and outputs into one unified and managed passenger and generic transit information system.

Being an integration platform, TRANSIS can connect to new or existing legacy peripherals and subsystems without modifying them and unify them into one reference open architecture information system. In doing so, it will **permit rapid deployment of new and future technologies** by allowing the MTA the mix and match of best of breed systems and peripherals without being locked into one proprietary sub-system or peripheral provider and all its tradeoffs. This will **greatly increase the speed and efficiency of refurbishment of existing cars as well as implementation of new cars,** while maintaining information connectivity with the rest of the fleet. Concurrently, the increased flexibility of peripheral technology choices will lead to **decreased deployment costs**.

TRANSIS makes possible the unification of new and existing legacy subway car information technologies by:

1. Providing technology in new and legacy cars that creates an open architecture, device agnostic, scalable communication platform for passenger information and maintenance information.
2. Providing a means of efficiently upgrading legacy cars with core communications technology such as data radio links, on-board train positioning systems, location aware services, and high definition LCD displays that can vary on each car-type depending on specific constraints.
3. Providing a means of efficiently upgrading legacy cars on-board passenger information to include next-stop announcements, dynamic LCD based line maps, near real-time connection information, and other operator/control center-initiated messages.
4. Providing a means of efficiently upgrading legacy cars to report consistent and standardized status for desired equipment and provide maintenance conditions back to the operations control center, independent of car-type.
5. Combining new and legacy car passenger information and equipment maintenance data into a unified information system creating one cohesive homogenous single point of reference, independent of car-type.

With TRANSIS storing the real-time status of all asset information from on-board individual rail cars including inputs from sensors and other subsystems, business logic can be added to perform such tasks as **predictive maintenance thus improving car reliability and reducing breakdown rates.** Thus, proprietary or inexistent on-board maintenance data can now be acquired and homogenized into one standard reference with TRANSIS.

TRANSIS improves the rider experience by enabling the transit authority to provide a fully integrated, multi-modal solution for their passengers and employees; be it real-time service interruptions or delays, emergency messages, institutional messages; or with pre-programmed messages. From the head-end message creation centers to the message end-point on the displays, interactive kiosks, and mobile devices it provides a fully-featured, wide area network-based transit information system suitable for meeting all modes of public mass transit information needs; wherever the user may be with a singular information reference for all. CSiT has been delivering on this type of service level of information on NYCT On-The-Go Travel Kiosk Stations for over 3 years with TRANSIS-Kiosk.

With a modern software architecture, TRANSIS can be deployed incrementally both in scale and features, so that **deployment costs can be spread out over time** using an evolutionary and non-disruptive building-block approach: start with a current project and implement gradually; potentially to other trains or modes. A testimonial to the quality of the TRANSIS product has been the use of an engineering and software design and development standard in line with NYCT'S CMMI-L2 criteria ensuring maturity and long-term support of the platform to NYCT and the MTA.

TRANSIS provides an evolutionary platform that evolves from a simple digital display system to an interactive kiosk with real-time and cloud-based experience delivery. It can be upgraded to include delivery of media (in conjunction with third-party CMS systems if desired) to mobile devices, trains, and the World Wide Web, and other systems. This connectivity can be possible because TRANSIS is open-architecture and non-proprietary in terms of information access and edge device compatibility. Via a system of connectors, TRANSIS allows legacy systems to be mixed with new systems and brought together into one uniform open system, creating a means to manage technology obsolescence via evolution and incremental upgrades without tearing down and starting from scratch. **This provides an efficient path for scalability, greatly simplifies future refurbishments, as well as the management of obsolescence of specific hardware devices, and can lead to even potentially implement new lower-cost strategies for Spares management.**

Moreover, should CSiT be retained for the implementation of its proposed strategy to implement TRANSIS across a significant part of the MTA rail car fleet, **CSiT will invest in a Development and Deployment Center in New York State.** CSiT is open to further discuss with the MTA as to the most appropriate location in New York State for its Development and Deployment Center. Once established, this Center will become the CSiT hub for implementation of all US-based projects.

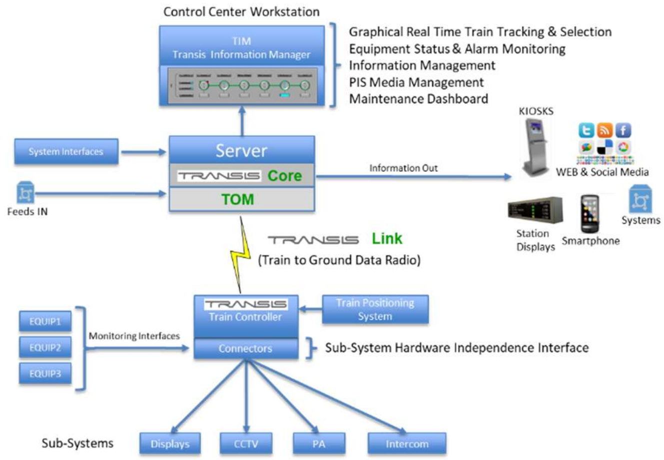
In summary, **CSiT's proposal not only importantly contributes in the near term to reducing the future capital and maintenance costs of rail car equipment**, **it also contributes to improve the overall reliability of the rail cars**, thereby increasing customer service levels, including communicating relevant and timely information to travelers with a world class corporate communication network.

CSiT believes that this proposal addresses all the Core Objectives as stated in the Genius Transit Challenge, and goes further by delivering many more benefits to the MTA in the short, medium and longer term; including providing the capability to expand the On-The-Go Network into NYCT trains as well as assisting in increasing advertising media revenues. Furthermore, new value for the MTA will be derived from the aggregation of the data using TRANSIS.

CSiT looks forward to the next step in implementing this proposal and would be pleased to explore this further with the MTA.

C. Technical Overview

C.1 High Level System Description and Architecture



The system shown above proposed in this solution consists of TRANSIS, a multimodal Transit Information System. The proposed equipment and software will allow the MTA to rapidly deploy a modern communication and information system across legacy and new subway cars, unifying the fleet with one information ecosystem across all subway car series.

The TRANSIS solution being proposed creates an information ecosystem by providing for a single point of reference in the collection, creation, storage, management, and digital distribution of all transit information within its sphere of operation and provides generic open system connectivity for peripheral subsystems both new and legacy. In providing open connectivity, it can also aggregate and unify data collected from all monitored field assets in the subway cars for enhanced maintenance functions. Business logic such as predictive maintenance can be used with the collected information to improve car reliability and reduce breakdown rates.

The different TRANSIS components are designed as a collection of software services (service providers), each with a service interface through which the functionality of TRANSIS may interact with the service.

This approach has several advantages. TRANSIS is highly scalable and maintains its performance level when it is changed in size, volume, or context in order to meet a user need. The TRANSIS architecture is modular and can be adapted on a project basis to meet specific client requirements. TRANSIS is able to integrate and interoperate with multiple external, internal, commercial (COTS) and custom applications. TRANSIS permits the separation of roles which facilitates the test and maintenance of the different applications. This results in time savings during the realization and deployment of TRANSIS. The addition and integration of new components (PA, PIDS, etc.…) and new external systems interfaces to TRANSIS has a minimal impact on the existing TRANSIS system software.

TRANSIS is structured around a base package and modular packages that add functionality. Each member of the TRANSIS family functions standalone or integrated with the other members of the product suite. In this way

TRANSIS can be configured to cover the information needs of a multi-modal transit system spanning from control center to all field assets. TRANSIS brings together many sub-systems new and legacy, combining them into a singular real-time information reference. An overview of the **TRANSIS modular product structure** is shown in the Supplemental Materials in Figure 1.

C.2 Control and Data Center Applications and Equipment

At the data center, redundant TRANSIS Servers are installed which run the TRANSIS-Core and TOM. These two services form the heart of TRANSIS. Other applications in the TRANSIS server include InfoCast which distributes open information to the various consumers such as other systems (feeds), smartphones, kiosks, and web/social media, and an open data API.

Other system interfaces to TRANSIS Core are possible via connectors. These interfaces can connect to systems like SCADA, Automatic Train Supervision systems, PA sub-system IP audio channels towards trains, data sources, and feeds. These interfaces will vary from project to project and amongst legacy and new subway car series. TRANSIS provides an open data interface to third-party systems for sharing data.

C.2.1 TRANSIS Server

High availability at the Data Centers is implemented in TRANSIS as follows: One cluster of two host servers hosting TRANSIS and the database. Primary and secondary roles for TRANSIS and the DBMS are distributed on the two host servers.

In nominal mode, TRANSIS Server 1 will be master. TRANSIS Server 2 will be the backup configuration. Data will be synchronized in real-time between the two servers.

The TRANSIS server applications will be configured as a high-availability group and can provide 99.999% availability. The servers are compatible to be run as virtual machines and/or in different physical locations for site redundancy if required.

C.2.2 TRANSIS-Core application

TRANSIS Core functionalities include data management (Data collection through feeds, data dissemination, data store management, etc.), Information processing (conversion of raw data into information) stored in TOM, system administration (Services monitoring, field equipment monitoring, alarm management, configuration, maintenance, etc.), Database management, train tracking, and user rights management with authentication.

TRANSIS Core also manages the interfaces (called connectors in the TRANSIS terminology) to external third-party systems such as CBTC-ATS allowing TRANSIS to receive train movement and schedule data and train composition & mission. It can also tie in to systems such as CCTV and SCADA to perform reflex actions based on workflow and/or data fusion. External CMS (Content Management Systems) can be connected to TRANSIS Core to enable standardized connectivity and management to information consumers like interactive kiosks and digital display systems.

TOM (Transit Object Model)

At the heart of TRANSIS is TOM which is an object-oriented information store in which each piece of data in the transit domain is represented by a standard generic definition along with contextual metadata. The various disparate heterogenous data sources are aggregated by TRANSIS and processed into standardized open information. It is TOM that enables TRANSIS to integrate heterogenous data coming from new and legacy systems into one homogenous representation.

TOM is updated in real-time from asynchronous multiprotocol data feeds with an event driven process and represents the heartbeat snapshot of all transit information within its span of supervision.

TOM adds an important layer of information governance to the system by performing consistency and error checking to data before storage, thus ensuring data quality management. The process of conversion of data to information is illustrated above.

C.2.3 TIM

TRANSIS Information Manager (TIM) provides an ergonomic and intuitive human-machine interface (HMI) offering a unified vision of the complete system from a single workstation or multiple workstations depending on configuration. TIM is accessible to operators, maintainers and administrators. TIM enables user interaction with the information system and allows creation, editing, and distribution of information to the passengers and workforce. The system can be expanded to include mobile devices, social media, and the web. TIM also provides system status, alarms, diagnostics, and maintenance functions via a centralized maintenance dashboard. This maintenance dashboard can manage connected assets across the entire fleet.

Via TIM, the user also manages the devices and peripheral sub-systems connected to TRANSIS enabling supervision, change of operational modes, and manage the maintenance tasks of the devices such as sending software updates or troubleshooting commands.

TIM provides the capability to integrate information management across the entire Comms infrastructure, including subway cars and stations/platforms with a consistent integrated HMI for the entire network.

C.2.4 Train Tracker

Within the TIM interface, there is a train tracker tab. The Map View within train tracker includes a graphical representation of each of the locations of the system (provided by the Railway Network Topology Services) at each of the hierarchical levels, ex: system, line, station, zone, room, for all of the locations within the system. Icons are located on the map for each of the components within the hierarchical view, including meta-groups and pseudo components.

The train tracker allows a real-time view of trains and their movement and position on a system map. The trains can be selected to send real-time or programmed PIS messages or other media, PA announcements, or to view CCTV streams from selected cameras on-board. Each train has a notification icon which shows any active alarms or status alerts. Any active maintenance alerts are also shown via the notification icon. Maintenance alerts cover all TRANSIS equipment as well as any connected third-party asset.

C.2.5 Passenger Information Management

The Passenger Information Manager provides the passenger information services. These components contain services to manage Passenger Information, public address, telephony, and emergency help points.

TRANSIS provides the function to manage messages and their priority to be displayed on digital signage or other information consumers connected to TRANSIS such as kiosks. Visual messages can be associated with audio or not. Messages can be automatic or manually (Ad-hoc) triggered. TRANSIS can also perform live audio announcements in stations or on the subway cars with priority management.

C.2.6 Maintenance Dashboard

The maintenance dashboard in the TIM workstation allows real-time and quasi real-time monitoring of all connected assets on board subway cars. As a baseline, all TRANSIS equipment and software is monitored and health status is shown on the train tracker interface as well as a on an interactive itemized list with color coded alert and status levels. Via TRANSIS connectors, other on-board equipment can also be monitored such as TCMS, event recorders, CCTV, sensors, I/Os, etc.

The maintenance dashboard can serve as a unified car subsystem health status indicator across legacy and new subway cars, getting quick alerts and repair turnaround on problems, increasing reliability, and increasing customer satisfaction.

For example, the door system relays and interfaces that may vary with each railcar type can now be imported into TRANSIS and the data inputs could be homogenized into a unified information environment of the subway car fleet door systems to be leveraged in near real-time with business logic appropriate to maintenance management of NYCT.

C.3 On-board Applications and Equipment

C.3.1 Unified Train Controller (UTC)

At the center of on-board TRANSIS functionality is the Unified Train Controller, a ruggedized certified train computer with open architecture. With its open connector capability, it can integrate control over 3rd party or TRANSIS sub-system peripherals for PA, PIS, Intercom, CCTV, radio links, and train positioning systems. It can also serve as a connector for supervision of on-board assets for maintenance.

The TRANSIS Controller (UTC) can be equipped as a standalone or in a redundant configuration for increased reliability and load sharing.

C.3.2 TRANSIS-Train

TRANSIS-Train is the on-board software that controls functionality and provides services for all connected sub-systems. It is connected in real-time or quasi real-time over punctual data links to the TRANSIS server at the data center. Via its system of connectors, TRANSIS-Train provides sub-system and information integration across the fleet, unifying legacy and new subway cars into one information ecosystem. Connected sub-systems can be Public Address, Passenger Information, Media, CCTV, Passenger Counting, TWC, TCMS, and data radio. TRANSIS-Train replicates a subset of TOM on-board the subway cars. The subset includes all information objects that are required for on-board information services. In this way information is kept consistent on-board and at the control center.

TRANSIS-Train on-board can be exposed via a TOD (Train Operator Display) HMI that gives the operator local access to initiate and control passenger information or to live view CCTV cameras.

C.3.3 Train Positioning System

For legacy trains that are not aware of their location, a self contained autonomous (TPS) train positioning system can enhance passenger information with such functions as dynamic line maps, next-stop announcements and near real-time connection information.

The TPS and location aware PIS can provide legacy cars with cost efficient and quickly implemented modern passenger information services. If a low bandwidth continuous back data channel on the train radio is available (usually combined with the driver voice radio), low bandwidth train position information can be sent back to the control center, enabling train tracking even between stations.

C.3.4 Monitoring Interfaces

TRANSIS-Train via its system of open connectors can provide maintenance supervision interfaces to 3rd party systems. The collected data is unified across the network and then stored in TOM for access by the maintenance dashboard or fed to other systems like predictive maintenance via an open API.

C.3.5 Summary of Key Benefits of the TRANSIS Solution

TRANSIS improves the rider experience by enabling the transit authority to provide a fully integrated, multi-modal information solution for their passengers and employees; be it real-time service interruptions or delays, emergency messages, institutional messages, pre-programmed messages, or service and maintenance alerts.

The disparate heterogenous data sources are aggregated by TRANSIS and processed into standardized open information. This enables TRANSIS to integrate heterogenous data coming from new and legacy systems into one homogenous single point of reference information store.

TRANSIS adds an important layer of information governance to the system by performing consistency and error checking to data before storage, thus ensuring data quality management.

With TRANSIS storing the real-time status of all connected assets from on-board individual rail cars including inputs from sensors and other subsystems, business logic can be added to perform such tasks as predictive maintenance thus improving car reliability and reducing breakdown rates.

TRANSIS can be deployed incrementally both in scale and features, so that deployment costs can be spread out over time using an evolutionary and non-disruptive building-block approach.An Open Architecture for interfaces and connectors allow rapid deployment on legacy and new subway cars.

D. SUPPLEMENTAL MATERIALS

Figure 1 TRANSIS Product Structure

TRANSIS **Base Package**	TRANSIS Core Server, TIM (TRANSIS Information Management Interface), TOM and information storage and management services
TRANSIS **Train**	Integrates functions and/or adds connectivity to new or legacy train borne PA/PIS/Media/CCTV sub-systems. Connects to 3rd party systems or CSiT supplied train equipment
TRANSIS **Station**	Station PA/PIS module: Integrates functionality for station public address and visual signage. Provides full integration across stations, lines, and all connected sub-systems such as PA, PIS, Media, CCTV, and Intercom.
TRANSIS **Bus**	Integrates functions and/or adds connectivity to bus on-board PA/PIS/Media/CCTV systems. Connects to 3rd party systems or CSiT supplied bus equipment
TRANSIS **Kiosk**	Adds functionality to manage a network of interactive kiosks, a Content Management extension module with campaign management with possible interface to 3rd party CMS, software that runs on interactive kiosks to present a UX (User Experience) for PIS and advertising
TRANSIS **InfoCast**	Gateway for information broadcasting across multiple simultaneous channels and consumers such as functionality to connect to interactive mobile devices, social networks, workforce tablets, or public connectivity with managed information services. High security with built-in firewall between operational and public domain assets. Managed interface allows control and monitoring of information outflow. Adds functionality to provide mobile access to TRANSIS, a Content Management extension module with campaign management with possible interface to 3rd party CMS, software that mobile device to present a UX (User Experience) for PIS and advertising.
TRANSIS **Mobile**	Adds functionality to provide mobile access to TRANSIS, a Content Management extension module with campaign management with possible interface to 3rd party CMS, software that mobile device to present a UX (User Experience) for PIS and advertising.

Figure 2: TOM Architecture, Creating intelligent information out of disparate data