Integrated Service Information and Management (ISIM): Coming Down the Tracks for NYCT: The Lettered Lines

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ABSTRACT

After the success of bringing centralized service management, communications and control to NYCT’s Sub-Division-A commissioned in 2008, we have been working towards a short and long term strategy using lessons learned when developing the same capabilities for the larger Sub-Division-B. This new initiative is called Integrated Service Information and Management (ISIM-B). Because of its size and complexity, ISIM will straddle three or more capital five-year programs and will be commissioned in strategically phased individual “Modules”. Using a Systems Engineering approach, we instituted a formal development methodology. This began with a well-defined project purpose statement along with clear project objectives and goals.

Early during the conceptual phase, we revisited our lessons learned database to help develop our plans for providing real-time situation awareness to the operations staff while at the same time improving the customer’s experience. With these goals as our fundamental mission, the following pillar objectives were developed:

1. Better service management by improving service monitoring and regulation;
2. Better management of safety and security by improving information sharing and decision making;
3. Better customer information by improving the quality, accuracy and timeliness of communication; and
4. Better operational plans and schedules by improving analysis of historical service data.

A BRIEF HISTORY OF THE NEW YORK CITY SUBWAY: MOVING WITH TECHNOLOGY

The New York City Subway is an amalgamation of the Interborough Rapid Transit (IRT) Company, the Brooklyn-Manhattan Transit (BMT) Corporation and the New York City owned and operated Independent Subway System (IND). The IRT is referred to Subdivision-A, and consists of the 42nd St Shuttle, and the number lines with the exception of the 7-Line (See figure 1 below). Subdivision-B consists of all the letter lines, the Rockaway Park and Franklin Ave Shuttles and the 7 line. The BMT is known as B-1 and IND as B-2. (See figure 2 below)

The IRT began service in 1904 and was the first real operating subway in New York City. This was followed by the BMT in 1923 and the IND in 1932. When no private agency could be found, the city decided to operate the IND subway lines.

The three systems were built by New York City through transportation bonds. The operations were then leased to the Interborough Rapid Transit and the Brooklyn-Manhattan Transit companies with the qualification that they could not raise the five cent fare without the permission from the Mayor. By 1940, not a single Mayor approved a fare increase. The lack of any fare increases along with the rising operating costs pushed the two companies into bankruptcy obliging the City to assume control of all the subway lines.

The typical rail configuration in Manhattan also known as the Central Business District (CBD) is four tracks; northbound local/express and southbound local/express. The outer boroughs of Queens, Brooklyn and the Bronx have branches of various configurations including four tracks, three tracks, where the center track is a bi-directional express service, and the standard two track northbound and southbound local only service.
In 1948, the first eNtrance/eXit (N/X) interlocking control system was installed at Euclid Avenue in Brooklyn which began the evolution towards centralized control operation. By the late fifties, this transition continued as individual local towers were aggregated into a Master Tower model.

In the nineties, NYCT began a paradigm shift from remote tower monitoring and control to central monitoring and control through technology upgrades. A new Rail Control Center was commissioned which would initially house two projects introducing two significant technologies to the transit system: Automatic Train Supervision (ATS) and Communications Based Train Control (CBTC.)

In 2006, NYCT commissioned ATS for Subdivision A (ATS-A). This system delivered both schedule-based train monitoring and tracking and automatic schedule-based train routing and control. It remains the largest automatic train control and supervision software system in the United States. It receives indications or sends instructions to approximately 20,000 discreet field devices including track circuits, switches, signals, and alarm.

The second significant project, a CBTC system, was installed on the Canarsie Line also known as the L line. This vital software system delivered moving block spacing, automatic routing and speed/service regulation. (Canarsie is one of two self-contained lines with the Flushing or 7-line being the other one.)

ATS-A and Canarsie CBTC along with a subsequent technology project, Public Address and Customer Information Screens (PA/CIS) for Subdivision-A, also delivers real-time arrival times to 180 stations, the internet and mobile devices.

LESSENTS LEARNED FROM SIMILAR PROJECTS AND THEIR IMPACT ON OUR DESIGN APPROACH

There were a number of lessons learned recorded on the aforementioned ATS-A project. These were categorized as functional, management and procedural. The following section will identify some of the key lessons learned along with how they have influenced ISIM-B.

LL #01 - Resisting the temptations of declaring premature success of project milestones and approving the associated deliverables.

The project team needs to be cognizant of the effects when giving in to schedule pressures. These include a false sense of achievement, and an inaccurate assessment of progress. This is amplified with software intensive projects because of the lack of physical progress that can be measured.

To mitigate this issue, the NYCT design team conducted a review of the Software and System Specifications. Vague language was identified and replaced or modified resulting in a clear set of requirements that specified the appropriate content of all deliverables. Data Item Descriptions (DIDs) were developed to provide an unambiguous set of expectations for delivery. The Software System Specification was

<table>
<thead>
<tr>
<th>Route</th>
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<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>Seventh Avenue Express</td>
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<td>3</td>
<td>Seventh Avenue Express</td>
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<td>4</td>
<td>Lexington Avenue Express</td>
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<td>5</td>
<td>Lexington Avenue Express</td>
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<tr>
<td>6</td>
<td>Lexington Avenue Local (Pelham Local/Express)</td>
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<tr>
<td>7</td>
<td>Flushing Local/Express</td>
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<tr>
<td>8</td>
<td>42nd Street Shuttle</td>
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Figure 1, Subdivision A Service

With the successful commissioning of these projects NYCT began the next phase of upgrading the Subdivision B, with CBTC Flushing, CBTC Queens Blvd Line and ISIM-B.

<table>
<thead>
<tr>
<th>Route</th>
<th>Name</th>
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<tbody>
<tr>
<td>1</td>
<td>Eighth Avenue Express</td>
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<td>2</td>
<td>Sixth Avenue Express</td>
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<td>6</td>
<td>Broadway Express</td>
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<td>7</td>
<td>Broadway Local</td>
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<td>8</td>
<td>Franklin Avenue Shuttle</td>
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<td>9</td>
<td>Rockaway Park Shuttle</td>
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<tr>
<td>10</td>
<td>Nassau Street Local</td>
</tr>
<tr>
<td>11</td>
<td>Nassau Street Express</td>
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Figure 2, Subdivision B Service
revised to include the requirements needed to satisfy each project segment.

A review of our internal processes is ongoing. This includes the use of interdisciplinary project teams to expedite project issues resolution and milestones. These teams will be empowered to make technical decisions and avoid the frustration caused by indecision.

**LL #02 – Understanding and memorializing the wants and needs of the User and Stakeholder community**

Complex, software intensive projects tend to have long lifecycles. Because of this it is not unusual to experience significant primary User and Stakeholder representative turnover during this period with a commensurate shift in direction. Established project requirements are put at risk.

To manage/mitigate this risk we are relying on our formal System Engineering approach. This consisted of getting consensus on the Project Purpose Memorandum, the Concept of Operation, an Alternative Analysis and the System Requirements. All requirements were bi-directionally traced to a user or stakeholder need. After a series of workshops, these artifacts were developed in a collaborative environment with an extensive signoff. (The System Engineering Process section describes this in more detail.)

We also embedded key users into the design team and will continue to use this approach during construction.

**LL #03 – The need for lifecycle traceability**

Previous Systems projects had vague requirements regarding requirement tracing. Some only referenced IEEE standards for Requirement Management. The problem we experienced is that the IEEE standards were considered “guidelines” and permitted too much flexibility in interpretation by some contractors. Our response was to revise the Software System Master specifications to remove and treat IEEE specifications as reference only documents. Figure 3 represents the tracing scheme now required within our specifications. The key points for us regarding tracings are:

- Tracing should begin during the Conceptual Phase to maximize our ability to perform system validation. “did we build the right system”
- Change is inevitable (AWOs: additional work orders) and there should be a workflow to trace them into the development lifecycle
- Prototype agreements should be considered requirement clarifications and, therefore, traced into the development process.
- Tracing to the software code is a challenge but, if software maintenance is an organizational objective, then tracing to a software configuration item should be a goal.
- All Test Cases should clearly identify the source requirements being tested. This will be used for system verification “did we build the system correctly”.

**Figure 3, Tracing Scheme**

**LL #04 – Developing the User Interface to enhance the user experience instead of developing a User Interface to mimic the existing operation**

The ATS-A system was treated as a signal project and therefore was seen as an extension of the signal system.

The legacy local tower route selection sequence is as follows:

- Entrance selection (User)
- Available Exit Presented (Signal System)
- Exit selection (User)
- Route selection is executed (Signal System)
- Flashing Yellow is presented to identify what signals are inhibiting route entrance selection (Signal System). In-depth knowledge of the uniqueness of the interlocking is needed to understand and resolve this condition.
This sequence was based on a discreet set of wired indications that offered no intuitive interaction between the User and Signal System. The ATS-A system was designed to mimic this interaction.

The approach being used on the ISIM project is to engage Human Factors Engineers early on and throughout the project. Our goal is to develop a more “user friendly” user interface that minimizes user actions while reducing the need for understanding site specific idiosyncrasies. A future sequence might be:

- Select a normal or reverse routing request object (User)
- Completed route selection is displayed (ISIM)
- An information bubble could be provided that explains why the route selection was not successful with instructions on how to resolve it.

**LL #05 – Develop a system that recognizes current operating conditions and service metrics and suggests Service Delivery options based on the interpretation of this data.**

Previous projects that offered automatic routing and rerouting instructions made these decisions strictly based on schedule without assessing the current operating environment or determining the impact of these decisions. It was strictly automating the basic actions of a Tower Operator with no logic towards improving service delivery.

ISIM’s goal will be to present service awareness to the operational users along with a series of options to optimize service. (Two new key functions Performance Monitoring and Decision Support are described in more detail in following sections.)

**LL #06 – The use of Automatic Vehicle Identification (AVI) Readers to identify and manage individual car numbers is costly and unreliable. An alternate method is necessary**

One of the many challenges we have faced when developing a comprehensive train tracking system is how to handle train movement in the non-monitored areas, specifically train yards. When trains enter the yards the tracking system can no longer monitor their movement. Therefore, when trains leave the yards to enter the monitored territory there is no reliable way to accurately associate the car numbers to the train consists.

In the Subdivision-A, we installed AVI car readers at all yard leads and AVI tags on all train cars. When the train passes a reader the car numbers are assigned to the newly created train consist. Although this proved to be an accurate method, it is also costly to install and maintain.

ISIM will support train identification needs with a Yard Management function that employs a combination of user procedures and software processes.

**LL #07 – Keep projects to manageable size**

There are many reasons why we want to keep the size of each project small including: 1) diversification of the risk spread over several projects/contractors, 2) better control over interim goals (that in turn could provide incremental value to stakeholders), or 3) it is made more manageable by limited NYCT resources.

We have also observed that combining software intensive systems with infrastructure installation and construction work adds significant risk to a project’s success. Infrastructure construction, particularly in a uniquely NYCT environment, is typically not part of the core business of firms that provide train monitoring and control systems and our experience has shown that they are surprised and unprepared by the complexity and extent of the resulting integration effort.

**ISIM OVERVIEW**

The ISIM concept is not that of a single project but a series of staged large and small projects organized to build one upon the other. We are calling each of the projects in the group “Modules” with their own master plan, scopes, budgets and schedules (application of LL #07). Collectively the ISIM modules support the strategic goals and objectives of NYCT while remaining within our financial profile for the entire effort. ISIM modules have approved funding over two 5-year capital programs with proposed funding for a third. Because of this approach planning is an essential element of the overall program.
Module 1: Integrated Signals Data Acquisition

The focus of Module 1 is to capture train and signal status from 26 field tower locations within Manhattan, Brooklyn, Queens and the Bronx and deliver this information to the Rail Control Center (RCC). It is primarily a network infrastructure project. Depending on location, this data could be transmitted across copper, fiber, and wireless technologies before tunneling over the SONET backbone network to the RCC. Once this information reaches the RCC it will be processed to deliver train location information to Service Delivery personnel via wired workstations and mobile tablet devices. This data while useful to operations after Module 1 completion will also be the foundation for the Module 3 Rail Traffic Management System and future CBTC projects. This project is primarily an in-house design with award planned for summer of 2015.

Module 2: Flushing Customer Communications

This module will furnish and install the public address speakers, customer information signs, the PACIS communication cabinet equipment and infrastructure at 21 stations along the Flushing Line. There are a number of innovations included with this project including the design and installation of a Passenger Station Local Area Network (PS-LAN). The PS-LAN is a fiber network ring connecting the communication room, fare areas and station platforms. As part of this network access nodes will be placed at key locations for connecting to the ring.

Module 2 will be able to support future projects such as, New Fare Payment, On the Go kiosks, CCTV camera, and Emergence Booth Communications System. LED signs on the station platforms will also be integrated with LCD signs in the mezzanine and fare areas using this network. The LCD signs will publish subway, bus and Long Island Railroad arrival information.

Module 3: Rail Traffic Management System

This module is the primary and most complex component to the ISIM program. It includes the design, development and commissioning of the rail traffic management and information system. This system is being designed as a highly available expert software system that will supervise the entire Subdivision-B. It includes a number of core capabilities such as Service Planning, Service Management, Incident Reporting, Historical Analysis, Reporting, Customer Information, and Resource Management.

It also includes a number of emerging capabilities such as Performance Monitoring and Decision Support (described in more detail in the next section.)

Module 4 Customer Communications Subdivision B

Module 4 is similar in scope to Module 2. It will furnish and install the public address and customer information equipment and infrastructure at approximately 180 additional Subdivision stations. The main difference is the challenges of quantity and funding profile.

Future Modules

There are a number of “placeholder” modules that are part of our long-term vision for continual improvements and future work. These modules are still in and early Conceptual Phase and may change as our operational strategy evolves however they are needed now for budget forecasting and capital fund planning.

The scope within these modules includes RCC architectural, communications, electrical and mechanical designs. Integrating ISIM with the Communications Based Train Control (CBTC) program to deliver a universal and integrated user interface may also be supported.

ISIM-B MODULE 3: RAIL TRAFFIC MANAGEMENT SYSTEM

The ISIM-B Rail Traffic Management System will deliver a number of core capabilities integrated into a centralized Control Center environment. There are also a set of new capabilities being developed that are a direct result of our lessons learned from ATS-A.
This includes Performance Monitoring, Decision Support and Yard Management capabilities. In developing these functions, we have solicited input from the Rail Operators and Rail Traffic Management Development community.

**Note:** For the discussion that follows a couple of definitions are in order. A corridor is a geographical area of tracks that could include a combinations of express/local, northbound and southbound services. Examples of this on the B-Division includes the 6th Ave, 8th Ave and Sea Beach corridors. A single track within a corridor between key interlockings is known as a branch.

### Performance Monitoring

There are two types of performance indications currently provided by the ATS system for Subdivision A. The first is the presentation of real-time train schedule and headway adherence. NYCT currently uses a green, white, yellow and red color scheme on all track displays to show degrees of schedule deviation. The second is quality of service metrics that are calculated after the service day is over and include on-time-performance and wait assessment.

ISIM-B will improve on this by delivering real-time service performance metrics also called Key Performance Indicators (KPIs) (application of **LL #05**). KPIs can be presented as an aggregated performance dashboard, individual site specific indicators, and/or string line charts. The objectives for this information is to provide early notice of a developing condition and the current health of service. NYCT has contracted the services of Human Factor Professionals to help during the conceptual phase. Human Factor activities will include understanding the relationship between the data and the required operator interactions so that an intuitive and robust User Interface can be designed and developed.

This information will be vital to ISIM and Rail Operation’s ability to make optimal service delivery decisions.

One popular interactive tool for visualizing service performance is the string-line chart. The example in Fig 5 represents a single train consists. The blue line represents the schedules for 0A 0724 LEF/207 (“A” train leaving Lefferts Blvd at 7:24 am for 207th St) and it’s next trip, the 0A 0822 207/LEF departing after a 4 minute terminal dwell. The green line represents the actual train’s progression; the line’s color is a KPI that denote deviation from the schedule. The red dotted line represents the predicted train movement. The vertical tics represent station dwell.

At 155th St the train is operating approximately 4 minutes late. The predicted arrival time at 207th St. will not be in-time to make its outbound departure time of 8:22. A configurable Alert will be issued when a “lateness” threshold is crossed thereby jeopardizing its next trip departure time. The Alert could allow sufficient time to execute a mitigation strategy. One such strategy is to implement a 5 minute service adjustment by using a “hook and drag” of the Blue line from 8:22 to 8:27.

![Figure 5, Stringline Example](image)

The following are other KPIs being considered:

- **Wait Assessment** – Is a measurement of customer wait time for a train at a designated station. The average actual wait time can be measured against the scheduled wait time. An increase of actual wait time can be representative of a developing blockage condition.

- **Branch Availability** – A branch is a section of track between 2 key interlockings. Branch availability is the measurement of how many trains can be added to the branch before capacity is reached. It is the difference between maximum capacity and current capacity.

- **Service Thru-put** – Is the flow of trains past a designated point over a defined time period. Measured against the scheduled thru-put can...
provide an early measurement to service delivery performance.

- **Schedule Adherence** – Is calculated and presented in terms of deviation between the train’s actual operating times and its planned or schedule times. Schedule Adherence is also known as on-time-performance.

**Decision Support**

Routine operations within Subdivision B involve executing the Daily Service Plan. When planned or unplanned events occur that affect this plan the Service Delivery staff must immediately be made aware of the situation.

Once aware of a disruption, Service Delivery staff will need to be able to develop and evaluate alternative strategies to minimize the impact on customers (application of **LL #05**). Often they must respond to a rapidly evolving situation to develop and coordinate both local and more global system responses to maintain the quality of service.

ISIM-B will provide the tools to help analyze conditions and propose a series of alternative actions. In order to achieve this we are developing a set of KPIs that will both alert the user of developing conditions and recommend a service strategy. We will also attempt to codify years of institutional knowledge through a series of interviews with experienced Service Deliver personnel.

In order to mitigate the risk of this new function, the ISIM team will develop a series of Operational Scenarios. One example is the “Effects of a Service Blockage”.

Using Figure 6, a 20 minute blockage on the northbound 6th Ave local, north of switch 247, is declared. The office system would

- Determine the number of impacted trains.
- Using KPIs such as the Branch Availability and Service Thru, ISIM would calculate the number of trains that can be routed to the adjacent express track before any service delays would occur.

For example, if a potential delay occurs on the 6th Ave express ISIM would evaluate alternate routes such as the 8th Ave local.

- In situations where all actions would result in excessive delays, ISIM could recommend removing train trips from service as a service relief alternative.

Figure 7, represents a possible response from ISIM. Selecting one of the options would trigger the automatic batch re-route which would recalculate the schedule for all affected trains. Selecting the Cancel option, would allow manual intervention. The expectation is that these KPIs would provide the necessary awareness to make a more informed service delivery decision.
Another Decision Support scenario is when an Operator manually routes a train off of its scheduled path. ISIM would compare established routes against the planned route. When they differ an Alert would be issued. If the Operator declares this to be an unscheduled adjustment, ISIM will propose possible service paths based on Service Delivery’s institutionalized knowledge that has been codified into the system. If the desired path is offered and accepted ISIM would then recalculate the train’s schedule. This ability is essential to maintaining the integrity of our countdown clocks and Service Performance metrics.

The combination of improved Performance Monitoring and Decision support will support our pillar objective towards improved service management and regulations.

Yard Management

ISIM is designed to deliver effective management of trains sets, cars and crews within Yards and other Storage locations. Effective management includes planning and execution of where trains and crews are, where they have been, and when and where they need to be (application of LL #06).

This process includes planning a series of manual train movements and recording the completion of each movement at which time the system will automatically update all applicable yard maps and movement sheets.

ISIM will also provide the tools to determine what resources (crew and cars) are available; manage car maintenance, car wash schedules and record non-revenue mileage.

SYSTEM ENGINEERING PROCESS

ISIM-B is the first NYCT project to follow a structured System Engineering approach. The process began with a series of workshops and interviews with potential customers and stakeholders. The output from this step was the issuance of the Project Purpose memo signed by our President which stated the purpose of ISIM, its long-term and short-term goals, and the four pillar objectives. Figure 8 was the centerpiece of that memo and is used at every project kick-off meeting and executive presentation. This ensures establishment of consistent expectations between the design team and all stakeholders.

This memo was followed by the generation of the Concept of Operations, Alternative Analysis, Whole System Requirements and Detailed System Requirements.

The four pillar objectives were expanded below to detail what is to be accomplished in order to measure project completion and project success.

1. Better service management by improving service monitoring and regulation. ISIM-B will provide Rapid Transit Operations (RTO) staff with real-time, graphical (e.g. string-line), centralized views of status and performance across the B Division, enhancing their ability to implement regulation actions quickly and easily and to monitor the impact of any regulation actions they have taken.

2. Better management of safety and security by improving information sharing and decision making. ISIM-B will improve the speed and quality of decision making in response to incidents by providing RTO staff with shared, consistent, and accurate information about train location, identity, and crewing on each train. In
addition, the status of infrastructure devices (such as fans), including information about their health, could be provided by ISIM-B as part of the shared view.

3. **Better customer information** by improving the quality, accuracy and timeliness of communication. ISIM-B will overcome the quality gap between B and A Division information by supporting the deployment of information delivery both in stations and via the web.

4. **Better operational plans and schedules** ISIM-B will make detailed historical data easily and promptly available for analysis. As automation improves both the quantity and quality of the data available, it will be possible to develop more efficient and effective schedules and plans that represent a better service offering to customers.

**Development of the Concept of Operation (CONOPS)**

A series of Operational Process diagrams were developed during the CONOPS phase a sample of which is shown in Figure 9. These diagrams were used to describe the “Day in the Life” user activities integrated with systems. Scenarios for both normal and deviation from normal operations were developed. The columns (swim-lanes) represent the steps performed by a particular system and user. The arrows represent the sequential flow events and the flow of information.

**Note:** The operations that are highlighted by a circle and letter represent those activities that will be influence by the new ISIM system.

At the same time that we were developing the Operational Process diagrams, we began to identify a series of high-level Operational Needs (Figure 10). Twenty needs were derived through a series of stakeholder interviews, workshops, and analysis. These needs were then traced back to the applicable pillar objective.

**Figure 10, User Needs Diagram**

The Operational Scenarios and User Needs formed the foundation towards developing the System Concept and System Contextual Concept. The System Concept (Figure 11) groups the functional concept elements into Capture, Integrate and Distribute actions. It also established the initial boundary between ISIM and the actors that influence or use the system.

**Figure 11, System Concept Diagram**

The Conceptual Context (Figure 12) diagram shifted the view from the users to external systems that will exchange data with ISIM. These systems fall into three
categories; the legacy systems that may need to be modified to interface with ISIM, those systems that will be subsumed by ISIM and those that may not exist and need to be developed.

**Development of the System Specification**

During our design phase the following system architectural views emerged.

Figure 13 is a top level, i.e. Level 0 or Context, data flow diagram. This diagram contains one functional process node (process 0: ISIM Office System) connected with all the applicable external system or elements.

During our design we developed an Interface Requirement Specification for each interface and included these as an appendix to our specification. The contractor has the responsibility to provide as built Interface Design Documents.

Figure 14 is the Level 1 Function Data Diagram. It identifies all of the top level functions that are described in our specification. This diagram shows the data flows between internal ISIM functions as well as their relationship with external elements.

Figure 15 is a sample of our Functional Specification. The numbering convention is consistent with the above System Function Diagram. Item 5.2.4 represents the fourth sub-function of the level 1 Service Planning function. Each section begins with a narrative which is
meant to provide an introduction to but, more importantly, as a way to convey their intended purpose and context.

This is followed by the specific requirement. Using IBM Dynamic Object Oriented Database (DOORs) requirement tracing tool, each requirement is uniquely identified. This database will be used for the entire project lifecycle. The final section or query table is also capture in DOORs. Since this procurement is a Request for Proposal, these queries are our way to solicit process and capability information from all bidders.

5.2.4 ESTABLISH AND EXTEND ACTIVE SERVICE PLAN

Implementing a System Engineering process is new for NYCT and therefore we are still having some growing pains. We are however committed to this approach and believe that formal SE processes will help maintain control over the project. We also believe leveraging the lessons learned from previous system projects like ATS-A and PACIS will help guide improvements for SE processes as well as our ability to deliver the B division ISIM system both in overall capability and the project within budget and schedule.

The System Engineering Group has worked closely with the Software Engineering Group to produce a number of formal methods and process specifications. These have included Data Item Description (DID) documents that provide format and content to Contract Deliverables and Method Sheets that detail the steps to an often repeated process or how to review and approve Contract Deliverables. We are piloting these processes and by following a Continuous Process Improvement (CPI) strategy expect them to be refined and mature over time.

We remain focused on our Formal Processes and through lesson learned and a Continuous Process Improvement (CPI) strategy expect them to be refined and mature over time.

If you have any lessons learned to share or ideas how we can improve our chances for success, please contact me at thomas.colacioppo@nyct.com.

Summary and Conclusion

At the writing of this paper the status of ISIM is as follows:

- **Module 1 Integrated Signals Data Acquisition** – Final Design has been approved and the project is in the Procurement Phase
- **Module 2 Flushing Customer Communications** – Has been separated into 2 distinct projects. The first project is for 6 stations and is undergoing a 60% Preliminary Design Review. The remaining 15 stations is entering Preliminary Design
- **Module 3 Rail Traffic Management System** – The Final Design has been submitted for review and approval.
- **Module 4 Customer Communications Subdivision B** – This is a significant effort that will span at least 3 Capital Programs. It is currently in Master Plan Phase.