Importance of Adequate Interface Management and Systems Integration

Navin Sagar, PE
HDR Inc.
Houston, TX

INTRODUCTION

Interface Management (IM) and Systems Integration (SI) deserve much needed attention as capital and improvement projects are getting more complex. European and Asian rail/transit properties have initially led us in realizing the importance, and subsequently developing and advancing the requirements for Interface Management and Systems Integration on a broader scale. Different project delivery methods, particular phase of the project, use of several contractors on the project, a new start or integrating new extension or improvement into an already operating system, mega-project involving multi-modal capacity build-out, all can bring unique challenges in terms of interfaces. The management of interfaces and systems integration will be essential at public agencies or private entities dealing with such initiatives as both those elements impact the project budget and schedule.

There are no hard and fast rules or relationships that exist to define the extent of effort that should be devoted to Interface Management and Systems Integration for the size or dollar value of a particular project. There are examples of some rail/transit agencies not paying enough attention to some going overboard in efforts regardless of the size of projects. Although the author advocates for paying attention to the size/value of the project that can economically be justified to watch the bottom line, it is not the intention of this paper to define such a relationship.

The paper will discuss the needs, approach, plan, and process for Interface Management and Systems Integration. Additionally, it covers traditional interfaces involved in a rail/transit project and emphasizes elements used for system integration to improve the efficiency and performance of capital projects. The author assumes that the reader is familiar with typical terms and implementation of rail/transit projects in United States.

INTERFACE MANAGEMENT AND SYSTEM INTEGRATION APPROACH

General

A focused and structured Interface Management and Systems Integration approach should be utilized for all major projects. A successful Interface Management and Systems Integration Plan should be documentable easily, have built-in tools for managing, controlling, tracking and verification of interface compliance to reduce the overall risks of the project from planning to start-up.

Fig.1 shows a typical framework of interface management approach that the author has successfully utilized on design-build projects.

![Typ. Framework of Interface Management](image-url)
basis, activities and associated organizational responsibilities.

Interface Management and Systems Integration Plan

Interface Management and Systems Integration Plan is an integral part of Engineering Management Plan. It ensures that:

- The Concept of Operation Plan (Con Op) is prepared by the client, thoroughly understood by the project staff and has been taken into consideration in planning of design elements.
- All design elements of civil/infrastructure and facilities are compatible within the facility and they are fully integrated with all systems elements.
- Civil/infrastructure and systems elements function as planned, designed and constructed.

Interface Management and Systems Integration Plan should be implemented using a systematic and documented approach to manage all interfaces. The Interface Management Process should allow for continuous monitoring and exchange of data during planning, design and construction. In addition, the exchange of data should be able to support testing and commissioning, pre-revenue service, reliability verification demonstration and Safety Certification. Process Fig. 2 shows a model of typical Interface Management Plan that was used on several successful design-build projects.

**Fig. 2 – Typ. Interface Management through Project Life Cycle**

**Basis of Interface Management and Systems Integration**

To have an efficient and effective interface management and systems integration, it is essential to initially define the basis that will be utilized or followed. Such basis forms the framework of requirements and often depends upon the scope of the work to be undertaken. The approach slightly varies for new starts or improvement projects and among established versus newer rail/transit properties. It includes following requirements:

- Con Ops defined parameters for desired Operation & Maintenance, including Reliability, Availability, Maintainability and Safety requirements.
- Interfaces between facilities, systems and vehicles.
- Interfaces with other systems.
- Interfaces with Stakeholders and utilities having jurisdictions.
- Interfaces must be:
  - Comprehensive to cover design, construction, integration, tests and commissioning, pre-revenue and simulated revenue phases.
  - Logical and precise structured to identify and trace upwards and downwards interfaces between design aspects and components.
- Interfaces once established should be monitored using document control and configuration control systems.

**INTERFACE MANAGEMENT PROCESS**

The objective of the Interface Management process is to identify, describe, clarify, resolve, document and control technical interfaces among the subsystems, systems, and infrastructure and among the project participants. The process is required for the functionality of the integrated system and for preventing cost overruns and schedule delays.

The Interface Management and Integration Process should continue throughout the project life cycle beginning from Planning through Acceptance of the Project in revenue operation and beyond. Establishment of this life cycle and adherence to it should be fundamental to the delivery of Project.
Fig. 2 also covers a project life cycle that is important to interface management because it highlights the relationship between the design phase and the system testing, commissioning, and acceptance phases. It is essential to ensure that the subsystem designs performed are capable of being tested and verified against the original requirements, including the subsystem interfaces.

**Interface Management Tasks & Documents**

Depending upon the scope, the number of interface management tasks may vary throughout the life and phase of the project. This highly depends upon the emphasis demanded by client and importance exercised by the consultant or contractor. Nevertheless, the following are some of the major Interface Management and Systems Integration tasks that are anticipated in a typical design-build project:

- Identify and define all interfaces for all phases
- Identify and define all internal and external interfaces
- Ensure that interfacing systems are designed to the same requirements
- Entities responsible for interfaces are identified, defined, and have committed for active participation
- Identify and resolve incompatible issues
- Ensure scheduled systems integration meetings and adequate communication have taken place
- Monitor and track impacts on compatibility in other areas due to changes made or encountered in one area
- Ensure that all interfaces are resolved and verified before starting pre-revenue and simulation revenue runs

Developing and maintaining Interface Management and Systems Integration documentation throughout the life of project is essential. The documents for management could become increasingly complex depending upon the scope, magnitude, number of interfaces to be managed and the entities needed to be coordinated on the project. The exhaustive details of these documents are not covered in this paper but traditional documentation encountered by the author on various rail/transit projects includes:

- Interface Responsibility Matrix
- Project Integration Implementation Plan
- Interface Tasks and Phasing Matrix
- Interface Block Diagrams
- Composite Drawings
- Interface Coordination and Systems Integration Checklists
- Test Plan
- Equipment Matrix
- Interface Control Documents
- Systems Integration Database

At times, this list is amended with subset sketches or matrix, as necessary. Additionally, certain rail/transit agencies now require three dimensional (3-D) technology supported drawings typically to show interfaces of specific interfering elements on the wayside, in underground tunnel or in elevated applications as well as in the station areas.

The development and maintenance of various documents demand considerable time and efforts, not only from the Systems Integration staff but also from the key staff in various disciplines on the project. Traditionally, weekly or bi-weekly Systems Integration meetings are used as a forum to conduct reviews and update the status of managing individual interfaces and to eliminate areas of conflict.

**ORGANIZATION AND RESPONSIBILITIES**

From the project inception, System Integration Manager assumes responsibility, accountability and authority of the Interface Management. He is supported by project and other systems integration staff.

Preferably on typical design-build projects, systems integration during design and construction should be led by the Systems Integration Manager. Traditionally, a Systems installer takes the lead for Systems Integration during construction but coordinates with Systems Integration Manager as he actively participates during the construction phase to support verification and validation of Systems Integration aspects against designed elements and through testing, safety certification and revenue start-up.

Fig. 3 shows a typical functional organization for Interface Management and Systems Integration on design-build projects. Often due to a number of entities involved, design-build contractors utilize a Technical Resolution Committee to resolve technical issues related to the Project. The committee consists of senior staff in the areas of technical expertise, safety, Quality Assurance and Quality Control. Systems Integration Manager can request the committee to help him as needed.
Historically, there has been a lack of dedicated staff for interface management and systems integration on projects. However, for major new start programs, it is advisable to assign sufficient staff dedicated to systems integration functions unless the discipline heads of the programs are available to devote considerable time to coordinate and integrate Systems elements with other elements of the program.

Design phase interfaces will include those for civil infrastructure, facilities, systems and vehicles related subsurface, utilities modifications, track and structures including guideway, systemwide and localized ductbank, manhole and raceways required. Construction phase interfaces include similar technical interfaces in addition to temporary power, staging areas and protection of construction sites followed by interfaces related to subcontractors and vendors. Other interfaces in this major category include:

**Stakeholders and Third-Party Interfaces**

Stakeholders and Third-Party Interfaces will be with authorities having jurisdiction, including public and private utilities and other owners or leasing company that have elements along the right-of-way having potential impacts.

**Infrastructure, Facilities, Vehicles and Systems Interfaces**

- **Infrastructure interfaces include:**
  - Subsurface work related to geotechnical, ductbank, raceway, manholes and utilities crossing and corrosion protection
  - Civil work at-grade including paving, sidewalks, roadways, OCS poles, foundations, bridges, structures, guideways, retaining structures, grounding etc.
  - Trackwork and special trackwork with guideway, vehicles, traction power, signaling and track bonding and wayside ductbank and switches

- **Facilities interfaces include**
  - **Interfaces at Stations:**
    - Plaza level, Kiss-N-Ride and Park-N-Ride areas and bus stop related
    - Civil, Trackwork, Structural, Architectural and landscaping
    - Mechanical, HVAC, Tunnel and Station Ventilation System, Plumbing, Fire/Smoke Alarms & Fire Protection System
    - Building Management System (BMS)
    - Electrical Power and Light
    - Traction Power, Signaling, Train Control, Communications, Fare Collection, Signage & Graphic Systems
Other Wayside Enclosures will have civil, structural and ductbank, manholes and ground grid related interfaces

- **Interfaces at Maintenance Shop & Yard:**
  - Power, signal and communications through the yard
  - Yard operations related specific interfaces, like snow melting equipment, switches etc.
  - Vehicles storage area and hotel power outlets related interfaces for overnight storage
  - Vehicle maintenance and repair functions related interfaces impacting day-to-day shop operation
  - Special shop systems related interfaces
  - Interfaces related to OCC if it is within the Yard and Shop
  - O&M Crews and other employee facility related interfaces

**Interfaces with Agency for:**
- As-built and record documentation
- O&M Groups for RAMS and O&M Planning issues
- O&M Manuals
- Training Documentations, etc.

**Interfaces with work by others for Agency:**
- Specific interfaces, including fiber optic cables, MH and ductbank related to Parking Garage Contract and other Plaza areas work
- SCADA and Operations Control Center System

**Interfaces involving Training, and Safety Certification**

**Training Related Interfaces will involve:**
Coordination with Rail/Transit Agency to finalize training syllabus, training schedule, trainees qualifications, pass/fail scoring criteria as well as vendors trainers qualifications etc.

**System Safety Certification related Interfaces with Vendors, installers and testers with Agency staff and others having jurisdictions to verify that installed and tested systems have been safety certified to function as intended and adequate paperwork is in order**

**Interfaces involving Test Plan Development, Tests and Commissioning Interfaces**

**Test Plan Development Related Interfaces will require:**
- Coordination with vendors, installers and testers to ensure that test plans are developed to comply with scope requirements and to seek approval for the test plan prior to test commencement
- Coordination with suppliers for factory tests, QA and test reporting requirements
- Coordination for field tests requirements and test equipment and for test preparations including test recording requirements, parties involved in testing and witnessing within the scope
- To understand requirements for supporting tests to be performed for the Agency by others.

**Interfaces with Rail/Transit Agency for Existing Operating Segment**

**Interfaces with Agency for Force Account Coordination:**
- Flagging, work train, revenue train with Operator, Access and Protection to already energized equipment/system
- Existing Infrastructure, Facilities, Vehicles and Systems Interfaces including those interfaces to existing traction power, OCS, signaling and communication system for maintaining seamless operation
Test and Commissioning Interfaces will require

- Coordination for Police, Safety, Security and QA/QC presence
- Approved Test Procedures and Test Preparations including test tools
- Test and Commissioning interfaces with various vendors, entities provided assemblies of various systems and installers
- Interfaces for SCADA and OCC System
- Facilities interfaces at stations and Shop/Yard
- Systems, Vehicles and Wayside elements interfaces
- Force Account support coordination for flaggers, general orders and communications bulletins etc for cut-over
- Others performing final acceptance testing
- Test participants and Witnesses related interfaces

DOCUMENT CONTROL

For all projects it is essential to develop and maintain proper documentation. Specifically, for interface management and systems integration itself, as mentioned earlier, several documents need to be developed. During design, construction, commissioning and test phases several project elements are being developed and revised. To keep track of those with ongoing coordination is challenging indeed. Systems Integration Manager usually keep track and maintain the status of documentation based on routine systems Integration meetings.

Majority of the projects utilize web-based document control methods quite successfully. Though there are several document control programs in the market, it is anticipated that systems integration manager utilizes the same document control program and system being utilized for the project.

Configuration control is a subset of Document Control requirements that will keep track of sequence of events and versions of documentation with the initiating and revising party labeled for each document, that is essential in case of any dispute that require resolution.

It is important that Systems Integration Manager receive training for document control procedure and work closely with Document Control Manager to develop and maintain status of Interface Management and Systems Integration documentation.

CONCLUSION

An attempt is made in this paper to elevate the importance of interface management and systems integration. It covers the essential elements of interface management and systems integration, including the interface management approach, plan, process, major tasks, organization responsibilities and various interfaces encountered in traditional rail/transit projects in United States. The author has referred several publications on systems integration and thanks their authors for providing certain useful fundamentals and guidelines in the subject matter. Additionally, the author has cited typical list of interfaces using lessons learned based on his experience in rail/transit projects and wishes that readers join him in raising awareness and importance of interface management and systems integration for its potential impact on the project performance.

REFERENCES

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