STRENGTHENING CONTRACT MANAGEMENT THROUGH SYSTEMS INTEGRATION

This article explores how the use of systems integration (SI) principles and techniques can shape a holistic approach to devising procurement plans, commercial models and contracts for successful rail program delivery.

April 30, 2020

By necessity, rail programs are split into discrete smaller elements for delivery through numerous supply chain contracts. How then can these contracts be brought back together to deliver a singular integrated system—a working railway—for the program owner and end users?

Bringing a systems integration approach to the overall program execution strategy, in particular for the contract and commercial aspects, is key to developing technology, engineering and program management solutions that work through all stages of the delivery lifecycle.

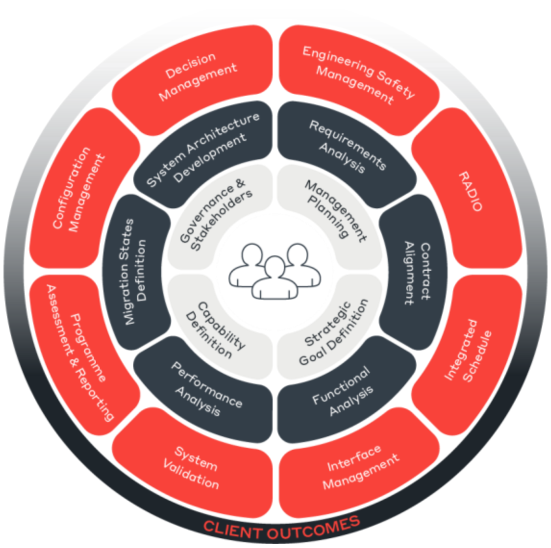

Figure 1 – Systems integration through the SI:D3 approach provides program leaders with practical methods for advancing contracts and other processes integral to complex rail programs.

SI can address the following main challenges for effective contract delivery:

— **Creating and disseminating accountability for overall SI**: How are the requirements, interfaces, functionality and capability of the system shared among the supply chain?

— **Delivering a complete operational system**: How do all of the assets come together progressively through the lifecycle to deliver a working system for the end users?

— **Coordinating the multiple contracts that make up the overall large-scale program**: How are the various layers of management, interfaces, schedules, designs and construction logistics coordinated among the contracts?

— **Accommodating different types of technology, delivery models and lifecycles in a single framework**: How is technology development risk mixed with the software development process and aligned with more traditional mechanical, electrical and civil infrastructure, which all have their own standards and lifecycles?

- **Dealing with a wide array of stakeholders**: How can the differing and often competing requirements of the parties involved with programs be understood and addressed? How can collaboration be encouraged to bring stakeholders together?

- **Handling uncertainty and change**: Due to the inherent complexity of programs, disruptive events, internal and/or external, will happen. How will the client and supply chain react and come together to tackle change effectively?

At the front end of the lifecycle, engineering is centred on translating the desired system capability and requirements from the sponsor organization into system designs and specifications that can be delivered by the supply chain. To that end, programs will be built by the supply chain and the bulk of capital outlay will be funnelled into the private sector. The importance of the way in which clients engage their supply chain cannot be over-emphasized; the approach to engagement often has a dramatic and persistent effect on the likelihood of successful outcomes.

A consequence of railway programs becoming larger, more complex and geographically extensive is that the supply chain capability, capacity and balance sheet all need to keep pace with the contracts that program owners expect the suppliers to commit to.

In the approach to procurement, there are five principle areas that SI can positively influence:

1. Defining the approach to integration and designating the prime systems integrator

2. Optimizing the contract packaging strategy – to reflect package size, interfaces, specializations and market appetite.

3. Supporting the selection of the appropriate form of the contract to enable achievement of the SI objectives – identify technology risk and uniqueness of application to inform the type of contract.

4. Approach to specification building – deciding what type of specification (i.e. input, output or outcome type) is best suited to procure the goods or services.
5. Estimate building – utilizing the technical system design to give more certainty to the estimate.

Designating the Prime Systems Integrator

To deal with the scale of rail programs, various forms of organizations and contracts have emerged—public-private partnerships, joint ventures, alliances and integrated program teams, to name a few, all of which must deal with the challenge of delivering an integrated system. A key question for the client (sometimes referred to as the owner or sponsor) is deciding who the prime systems integrator is, as this choice will impact the downstream packaging and contracting approach. Factors to consider include the level of accountability that can be legally held (such as safety authorization) at different levels of the organization, the type of stakeholders to be engaged with, the skill of the supply chain to take on SI activities, and the level of technical risk associated with delivery of solutions.

What are the options?

- The client or owner is the systems integrator – the client acts as the prime SI decision-maker and overall leader.

- A third-party specialist is appointed as systems integrator – the third party acts as the systems integrator with delegated authority from the client.
- One of the supply chain contractors is the systems integrator – one of the contractors oversees the other contractors with the client in an assurance role.

- SI responsibility is disaggregated across the supply chain – the supply chain is expected or incentivized to collaborate and undertake SI collectively with the client acting in an assurance role.

In recent times, an erroneous idea has often governed the practice of SI—that SI can be de-risked for the client by disaggregation, or contracting out the accountability for SI entirely into the supply chain. This contracting strategy has proven to be difficult to implement because of lack of clarity of leadership and transparency regarding SI issues.

Alternatively, SI activity can effectively be mandated through the various levels of the organization, where leadership is retained by those with the technical capability, and decision-making and financial authority.

Building Specifications

All major programs are delivered by a complex network of suppliers with relationships governed through a set of specifications. The technical specifications through which the program is delivered forms the foundation of good governance, and the selection of specification type is critical for goal alignment.

There are three main types of specifications (input, output or outcome), which vary in the level of prescription and how risk is shared between the client and the supplier. The three specifications sit on a continuum where an input-based specification provides a very detailed, directive description of scope; output-based specification steps back from specific details and outlines what outputs the client is seeking to achieve; outcome-based specifications provide high-level, objective-orientated requirements that encourage the supply chain to innovate, promoting understanding behind the real reason for undertaking the program.

In certain cases, an input-based specification might make sense—where a contract demands exacting requirements, the client knows precisely what is required, or the solution will be heavily constrained by technical standards. In contrast, if the contract solution is unclear to the client or has a high degree of uncertainty and innovation, then the situation might lend itself to a looser specification, based on outcomes. Typically, outcome-based specifications provide significant latitude for suppliers to innovate and add value; however, this leeway should be tempered with collaboration clauses in order to promote goal alignment.

An outcome-based specification may lead to the client relinquishing more control to the supply chain. This can feel uncomfortable; but experience demonstrates that with appropriate management and assurance the trust in partners who are given the freedom to innovate leads to better solutions. Allowing the supply chain to design against high-level outcomes gives the client the time to focus their efforts on protecting the integrity of the overall system design and integration, an area that must rest with the client and should not easily be "contracted away."

Optimizing the Contract Packaging Strategy

The challenge that program leaders face is achieving the difficult balance between minimizing contractual interfaces while keeping contract values to a level that are attractive to the market; this task is increasingly difficult as programs get bigger and increase in complexity. As programs continue to grow in scale, the value of contract packages may become out of step with the ability of the supply chain to underwrite the value of the contract and provide mutually agreeable commercial protection to both parties.

The allocation of scope between contract packages will always present a range of factors that will need to be carefully assessed, such as natural boundaries, common components, site location and market appetite. However, by representing the total system design, scope can grow, shrink or transfer between contracts, allowing the cause and effect to be easily visualized and impact assessed.

The proliferation of contractual interfaces can create an environment whereby the supply chain raises commercial claims based on the performance of other suppliers, creating a domino effect of commercial turbulence, as recently reported in a Crossrail National Audit Office report[1]. The use of system architecture diagrams can help identify how the assets are partitioned into the different contract packages. The geographical view of an architecture can provide insight into the distribution of assets along a rail corridor; assets that are clustered together can be grouped into the same procurement package, avoiding situations where multiple suppliers are working across dispersed locations.

It is best to write early-on—as part of the tender and contract documentation development—interface specifications or interface control documents to clarify the relationship between contractors through the design, construction, testing and commissioning stages. This tender development step requires the client to develop the overall system architecture, associated detail in the system design, and then disaggregation of interface and allocation of these contracts for delivery. A painstaking activity, but one that enables interface risk to be managed at later stages in the lifecycle. Interface should also be coordinated with the schedule through the development of integration milestones, i.e. higher risk points in the schedule where multiple contracts combine to deliver a tangible system output such as the proving of system functionality. These then enter into the contract as contractual milestones that bind contract packages together and encourage collaboration to progressively work toward the integrated system.

Selecting the Appropriate Form of the Contract

A full technical appraisal of the scope that needs to be delivered, through the lenses of technology, complexity, novelty and delivery pace, will inform the most appropriate contracting model. All contracts fall within a spectrum from fixed price to variable price with the buyer's risk increasing as the compensation model moves toward the variable end (and conversely for the supplier). Key decisions for the client that will impact the form of contract are:

- What type of specifications are supply chain contracts going to be based on – input, output, or outcome type specifications?
- What level of detail specification and design is the client willing and able to undertake?
- How much SI needs to be undertaken across contracts to get a successful outcome? (i.e. Can contracts be managed separately in silos, or is there

[1] Completing Crossrail, April 2019, Department for Transport, National Audit Office, United Kingdom

a high degree of interdependence and need for collaboration?)

- What is the likelihood of change? Are there significant technical uncertainties, technologies to develop or stakeholders that could change the scope?

Where scope is stable, boundaries are clear and there is low complexity, a fixed price type of contract such as New Engineering Contract (NEC) Option A (price and schedule) or Option B (price and bill of quantity) is perfectly adequate; where there is more uncertainty in the scope, a more flexible form of contract is needed, such as NEC Option C (target price and schedule) or Option E (cost reimbursable).

Programs that are highly complex through scale, interfaces, technology and novelty require more flexibility and collaboration in general. As far as SI is concerned, contracts that enable flexibility allow for variance, as it is difficult to predict at the start all of the risks and development activities needed.

Any attempt to use a fixed price construction-oriented form of contract for a program that exhibits a high degree of novelty, such as a software intensive train control system, is likely to be sub-optimal. A contract form that is based upon payment against measurement of a tangible asset, i.e. length of guideway installed, will not be effective for contracts that are much more subjective and nuanced, i.e. lines of code tested, where a more agile type of contract should be sought.

The global trend of engineering and construction companies consolidating through merger and acquisition can present a range of opportunities and risks. Multinational vendors typically offer an end-to-end solution that can de-risk the SI effort, as all products will be backward-and-forward compatible and hot-swappable, with economies of scope that can be maximized. The drawback, though, is that the client can often pay for "bundled" products and services that will never be exercised in their specific application. However, for systems that have a diverse range of legacy interfaces with bespoke protocols, a commercial-off-the-shelf solution might not be appropriate as many of the standard interfaces will be nullified.

Building Reliable Estimates

There is broad consensus that building reliable estimates at the front end of the lifecycle is notoriously difficult, with order-of-magnitude variances often the best that can be hoped for. Combining the system architecture diagrams with a system breakdown structure detailing the equipment types and quantities can provide a powerful instrument for deriving the capital expenditure estimate. This approach allows the estimating team to perform a "take-off" from the diagrams—building a bill of quantities and ensuring that all system elements are present and accounted for, resulting in a more reliable estimate.

Closely allied with program management techniques, the use of breakdown structures coupled with architecture diagrams provides confidence that all system elements are captured and aligned from technical and commercial perspectives. This way, the whole structure of the system can be visualized at differing levels of abstraction depending on the specific needs of the audience.

Over long-life programs, covering multiple decades, migration state planning is essential to understand when benefits will be released and when each individual project will deliver its scope. The migration planning can be combined with the system breakdown structure to provide a temporal view of when assets will need to be delivered to achieve a migration state. The additional level of richness can be added to the estimate by using the temporal phasing to create an annualized capital expenditure spend profile. As program plans shift and evolve throughout the lifecycle, having the spend profile firmly traced back to scope delivery can help program leaders analyze the cause-and-effect; for example, the reinforcement of the power supply is necessary before the introduction of new rolling stock and increase in performance.

***

The principles and techniques of an SI framework should be woven into all program delivery aspects to promote a low-risk delivery model and maximize the effectiveness of the procurement. The success of this undertaking will ensure that full value of the SI approach is realized and that the SI function remains relevant throughout the life of the program.

The technical characteristics of the system, how it is partitioned and the end-user requirements should dictate the overall approach to procurement and contracts, and crucially not the other way around. The appraisal of the correct level and type of specification can avoid wasted effort, expended by specifying too early or without enough information, and accelerate the speed by which clients engage with the market. Through gaining a better understanding of the capabilities of the market and using soft-market engagement, clients can reduce the risk of contracts becoming adversarial and misaligned with the program's objectives. By taking an engineering-led approach to building contractual models, underpinned by the use of SI techniques, program leaders can instil an increased level of commercial confidence in those who fund the investment.

Authors

Darren Grey
Associate, Systems Engineering and Integration
United Kingdom
Darren.Grey@wsp.com

Nassar Majothi
Deputy Head of Discipline, Rail
United Kingdom

About WSP

WSP is one of the world's leading professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, architects, planners, surveyors and environmental specialists, as well as other design, program and construction management professionals. We design lasting solutions in the Transportation & Infrastructure, Property & Buildings, Environment, Power & Energy, Resources and Industry sectors, as well as offering strategic advisory services. Our talented people around the globe engineer projects that will help societies grow for lifetimes to come. wsp.com