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System Integration Risk in Public Private Partnerships

Damian Morris[1], José de Ponte[2] and Tim Lyons[3]

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www.scl.org.au

[1] damian@moso.com.au
[2] jose.deponte@dlapiper.com
[3] tim.lyons@dlapiper.com

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1 Introduction

The delivery and integration of technology systems is often a key element of the scope of an infrastructure project, but there are a number of fundamental differences between delivery of technology projects and construction of physical infrastructure. Attempts to use contracts from an infrastructure project's contract suite, in particular the D&C Contract, as the starting point for a technology subcontract will run into problems unless these differences are recognised and taken into account.

Technology projects usually involve delivery of a system – a set of things (hardware and software) working together as parts of a mechanism or an interconnecting (and often variable) network; a complex whole. By contrast, physical infrastructure is often delivered as a set of components that only interact with each other in more limited, static and generally well-understood ways. The typical D&C Contract was not built with the challenges and risks inherent in technology projects (in particular, system integration risk) in mind and it is necessary to adjust a number of the levers to address this.

1.1 Complexity

Technology projects more often than not involve the delivery of a bespoke system, even where the key components are based on off-the-shelf products. The systems delivered by technology projects are generally built or customised for the Customer's specific use cases, and thus the Customer generally engages closely with the Contractor to ensure the delivered system meets the Customer's specific needs. Technology Customers are accustomed to actively owning the outcomes of technology projects and working closely with their Contractors, including by giving directions to their Contractors throughout the design, build and even verification stages, to produce a product that has been highly customised to the intended application. By contrast, Customers of major infrastructure projects are typically cautious about engaging too closely with their head Contractors for fear of taking on additional risks to those already set by their contractual arrangements. Construction Contractors expect and price for an adversarial risk allocation. Systems Contractors on the other hand, being more accustomed to a collaborative approach to risk, are not so used to adversarial risk environments and consequently have a much lower risk appetite than many construction Contractors.

Often, construction Contractors (and many others) believe they are buying a commodity with a technology subcontract; a "piece of kit" that "should just work". The day that technology systems are procured with a 1-page order form, this will be true. Until then, it is worth considering what the standard use of bespoke, multi-hundred-page Functional and Performance Specifications truly represent – the requirement for a bespoke, one-off system, highly customised for a very specific set of purposes that have never been documented before in this precise form. The single most effective way to reduce the delivery risk in a technology project is to reduce the customisation required to deliver it; if a project can't reduce the size of its FPS then by definition it is asking for something new.

1.2 Time

Another powerful mitigant to technology delivery risk is simply time. It is employed by scheduling the project activities such that the delivery team has the greatest possible chance of uncovering

issues as early as possible, so that they can be resolved in time to complete the project by the contracted dates. Technology delivery teams understand this intimately, and a mature technology project delivery team's schedule will invariably reflect it. Conversely, one of the greatest risks to the successful delivery of a technology subcontract in an infrastructure project is frequently the D&C Contractor's disregard of that schedule, and the consequent creation of delay risk where none previously existed. Of all the risks discussed in this paper, this is the easiest for the D&C Contractor to solve. It is also the hardest for the technology Contractor to manage.

1.3 Market power

Construction Contractors inherently work with and deliver physical inputs and outputs, and consequently are almost always local, even when they form part of a much larger regional or global organisation. Technology Contractors, on the other hand, work largely with digital inputs and outputs, and as a result are able to deliver their goods and services to Customers across the globe; often, their only local resources, if any, are their sales teams. Technology Contractors frequently have a correspondingly less parochial outlook than construction Contractors. One of the most fundamental differences to Customers arising from these different postures is the need for construction Contractors to work within the constraints of their local markets – i.e., to be willing to accept market-standard contractual arrangements when they are not able to negotiate a better outcome.

By contrast, technology Contractors are far more able and willing to mandate contractual arrangements on a largely "take it or leave it" basis, as they are able to enter and leave local markets according to whether those markets align with the Contractor's preferred risk profile far more easily than construction Contractors. The extent to which a technology Contractor delivers a digital product that can be delivered remotely (for example, a cloud project management software service) as opposed to a human service that must be delivered locally (for example, the integration of such a project management system into a customer organisation) directly affects their power in this regard.

Today, almost every technology system is itself built on complex third-party sub-systems, which are often themselves also provided by global suppliers. This results in limited opportunity to control the direction of feature development, not to mention the correction of defects, in the myriad third-party sub-systems that technology projects depend on. This similarly often limits the opportunity for customising those sub-systems to the extent necessary to fully meet the customer's specific requirements for any given project, and it almost always completely eliminates any opportunity to pass down risk and/or liability to the third-party provider.

(It is often possible to do both for open-source third-party subsystems, but other than for the most complex, bespoke projects this is frequently not an advisable approach, as it inevitably results in a bespoke "fork" – a custom implementation – of the third-party subsystem that is neither owned nor maintained by the third-party, and thus receives neither improvements nor defect fixes from them. This creates either an evolutionary dead-end or else a permanent maintenance obligation on the project, the avoidance of which was a primary reason for using the third-party sub-system in the first place.)

Reliance on third-party sub-systems further increases the overall complexity of technology projects and simultaneously reduces technology Contractors' appetite for accepting design and delivery risk

transfers from their Customers. As a direct result, many projects are predicated on using third-party sub-systems and components “as-is”, with the Customer inherently taking the risk that they do not quite meet the specific needs of the project. (Generally, technology Contractors still take the risk of selecting third-party sub-systems that are generally fit for the project’s purposes.)

1.4 Integration

Technology projects often involve the integration of multiple discrete systems, each of which has been designed and developed individually and without regard to the specific other systems with which the project requires that they integrate. Usually, some of the systems are being delivered through the project, and some are existing systems that the new ones must integrate with. This divide alone can create complex interactions of responsibility (which sits with the parties responsible for delivering the project) versus capability (which exists only in the third parties with the capability to make the necessary amendments to the existing systems), further complicating the overall project risk profile.

These factors lead to very high levels of interface points – and thus integration – in technology projects, even before external interfaces are considered. By contrast, although the number of interfaces in a typical construction scope may be similarly large, they use standard interface specifications and protocols – for example, those found in every construction project’s Issued for Construction drawings. The technology sphere innovates far too quickly, and product cycles are far too short, for more than a tiny subset of interface points to become industry-wide standards. Indeed, technology vendors often deliberately avoid standardising interface points, unless the standard that is accepted is that vendor’s own specification, as a key plank in the tech market’s infamous “vendor lock-in” market acquisition and protection strategy.

As a result of these factors, design, delivery and integration of bespoke systems requires a level of verification, and subsequent defect identification, analysis and correction, that is not normal in well-delivered construction projects but is common in even successful technology projects. The “V”-model of systems engineering is widely used in successful technology projects, and is an approach that can also help tackle the increasing complexity of construction and infrastructure projects.

These differences in complexity result in dramatic differences in the respective risk profiles of technology and construction projects, and drive significant differences in how their risks are, or should be, treated. Risk mitigation strategies that are frequently used to effectively manage construction risk can be ineffective when applied to risks commonly encountered in the delivery of technology systems. Attempts to use traditional construction D&C contract risk allocations and mitigations to manage the technology risks in a construction project often result not just in an inefficient risk allocation but also an ineffective one.

This paper focuses on these differences in risk and their impact on effective risk allocation. It reviews common approaches to delivery risk allocation and management in construction and technology D&C contracts, and highlights where approaches that are fit for purpose in a construction context fail to deliver the same outcome in a technology integration one. A number of approaches for addressing these gaps are identified and discussed.

2 Complexity

During the 2000s a number of significant road infrastructure projects in Australia, particularly those requiring extensive tunnels or particularly long stretches of motorway, were delivered as PPPs, often with ProjectCo taking the demand risk for traffic for the completed project. In many if not all of these projects, the development, integration and commissioning of the tolling system proved to be a substantial risk to the success of the overall project, out of all proportion to the size of the tolling system contracts relative to the overall cost of the project. As a result, tolling systems developed a well-deserved reputation for posing out-sized risk to road infrastructure projects, and in subsequent projects received extremely close attention from every major stakeholder in the project, from the State down and from the commencement of procurement all the way through until the point of successful project completion and asset operation.

This additional and intense focus on tolling system risk resulted in significant improvements to the rate of success of tolling systems subcontracts through the 2010s, as each new project strove to procure proven tolling systems, rather than “innovating” (which itself became a dirty word), and then carefully avoided specifying functions or modes of operation that were outside existing, and therefore proven, functionality.

As a result, the level of development risk in most tolling systems projects in the 2010s was actively reduced to the absolute minimum necessary to deliver the project.

Software and hardware development risk is all too often not under the direct control of the project parties, as development usually takes place in specialist groups inside the vendor and usually according to a product roadmap already developed by the vendor. Although this roadmap takes into account the changing needs of the vendor’s markets, by definition it is also subject to the needs of multiple customers and projects at the same time, resulting in competition for attention that is usually solved by selecting for either the loudest, nearest, or otherwise most important projects first. This is often not your project at the time when you really need it the most, and thus adds to the risk factors for your project the risk factors for all the other projects it is currently behind in the vendor’s priority list as well.

The significant reduction of development risk allowed the project parties to 2010s road infrastructure projects to focus on the integration and commissioning risks posed by their tolling systems sub-contracts, which generally are under the project parties’ control.

There were numerous other factors that reduced the risk of tolling systems projects in the 2010s relative to the 2000s - not the least being the commoditisation of computing power, data storage and communications networks bandwidth and latency, which resulted in the ability to solve complex software problems through the quick, simple and reliable means of simply throwing hardware at it - however, the all-but-elimination of development risk also meant that these other improvements were less necessary to get the job done than they had been previously. This resulted in greater certainty of time and cost for all project parties, which results in improved margins for all the project contractors up the contracting chain and improved certainty of delivery for the customer that commissioned the project in the first place.

This approach to minimising or even eliminating development risk can almost always be applied more aggressively than first instincts suggest. As a customer, you are always faced with the choice of modifying the system that you're procuring to meet the needs of your organisation or modifying your organisation to align with the way that system already operates. Sometimes this choice will be best served by modifying the system, especially if it's core to the operation of your entire business and you have a very large business, but rarely do you not have the choice of choosing a more optimum point on this spectrum, at least from a risk perspective.

In a PPP the operating organisation is generally created as part of the same project that delivers the asset and its operating systems. This makes PPPs perhaps the ultimate opportunity to reduce technology risk by modelling the new organisation and its processes sympathetically with the core systems that are being procured, rather than procuring new systems that must then be customised – at the cost of both time and money, and thus risk – in order to integrate with the new organisation.

3 Time

Sometimes contracting parties take all the relevant steps discussed in this paper and elsewhere to effectively avoid as many of the risks presented by a technology subcontract as possible, and to mitigate and/or monitor the remaining ones, only to then undo all of that important work by ignoring the resulting provisions when actually delivering the project.

Nowhere is this more common, or insidious, than when contracting parties ignore the role that the project schedule plays in mitigating so many of these risks, and depart from or even simply ignore the schedule they spent so long negotiating during procurement.

In particular, construction Contractors frequently spend enormous time and effort negotiating delay regimes and associated delay liquidated damages in key technology subcontracts only to then ignore the schedules they are predicated on during project delivery, perhaps in the belief that solving the technology issues encountered during project delivery is a motivational problem (and thus solved by the threat of liquidated damages – *in terrorem*), rather than a technical one (for which time, effort and expertise are by far the most important success factors).

There are many reasons why this issue arises, with unexpected and unrelated construction exigencies taking precedence over the technology subcontract activities being perhaps the most common, but the effects are always the same. Complex problems that could likely have been solved in time if they were unearthed under the planned schedule – which was prepared specifically with the risk of such problems and their solution in mind – are not encountered until too late in the project for an effective solution to be implemented by the contractually required dates, necessitating commercial solutions in addition to or as a substitute for technical ones.

In short, one of the key risks to the successful delivery of a technology subcontract in an infrastructure project is often the D&C Contractor, even when the D&C Contractor is the counter-party to the technology subcontract. Of all the risks discussed in this paper, this is the easiest for the D&C Contractor to solve and the hardest for the technology Contractor to manage.

4 The "V" Model of Systems Engineering

An explanation of the V model of systems engineering is beyond the scope of this paper, but it is worth noting that this is one of the most common formal methods that technology projects employ to manage their complexity.

The authors note that the V model is gradually being introduced to traditional civil and mechanical engineering disciplines as a way of dealing with their own increasing complexity, and encourage stakeholders in infrastructure project delivery to become more familiar with it. It is by no means a silver bullet, but it is a way of breaking down complex project scope into complementary layers that each deal with "the right level of complexity, and no more".

This also makes it relatively straightforward to ensure that the appropriate stakeholders for each level of complexity are responsible for agreeing the definition of that layer during the design phase (as part of requirements analysis and derivation), and then reaching formal agreement during the Acceptance phase that the project has successfully delivered (or not) those requirements.

5 Constant Reinvention

Construction has been practiced, in its many forms, for thousands of years. Even large construction projects – resulting in structures that we recognise today as "infrastructure" – were *engineered* thousands of years ago in a way that is recognisable to today's engineers.

By contrast, complex systems are a relatively new discipline, and high-technology systems newer still. We have only been developing systems that we would recognise today as a "technology system" for less than a century, and we are far from good at it – at least, if our measures of "good" include "on time" or "on budget".

As a result, the software development industry in particular is constantly reinventing not just the tools, technologies and architectures that their products are built on but also the very methodologies and processes that they use to design and implement those tools, technologies, architectures and products.

Delivering the technology systems that form part of an infrastructure project in the same way they were delivered for infrastructure projects from as recently as five years ago can thus involve forgoing significant strides forward in technology and processes, and consequently in time, cost and risk reduction.

At present, the proliferation and pervasiveness of cloud-first technologies, methodologies and services in general, and of "construction-tech" products and services in particular, represent a significant opportunity for infrastructure projects, as the use of mobile-first technologies did over the past decade.

6 Components

The re-use of existing components – often complex systems and sub-systems in their own right – can significantly reduce numerous key project delivery risks. These include not just the risk that designing and developing a sub-system takes much longer and costs more than expected, but also the risk that once built, the design is not fit for the project's purposes or otherwise requires unexpected changes to other systems or sub-systems in order to operate as required. These unexpected changes can have a substantial flow-on effect, in turn requiring further unplanned changes to yet more sub-systems.

All too often, the effects of the required changes are too complex to reliably model in advance, creating yet more risk that the changes will ultimately not achieve the desired outcome, leaving the Contractor (and the Customer) back at square one (and likely having to undo all the changes, creating yet more change risk). These are all common types of integration risk in systems projects.

Ultimately, the use of existing components reduces the underlying risk that that the parties will need to agree changes to the contracted price, scope of work, and/or functional and performance requirements in order to complete the project at all.

ICT projects have developed numerous ways of mitigating these integration risks. None of them eliminate integration risk, but a combination of these approaches can considerably reduce it.

First and foremost, is the use of off-the-shelf components wherever possible. For both cost and risk reasons this approach is usually taken to its practical extreme – that is, wherever possible, the system being delivered is itself based on an existing, and *proven*, system that has already been successfully delivered elsewhere. (There can be significant benefits to being the first customer of a new system – not the least being that the system is usually built for your specific needs – to offset the risk, if not likelihood, that it will both take longer and cost more than either the Customer or the Contractor anticipates at the outset.)

In these cases, a critical question that a well-informed Customer will seek to answer during procurement of the system is how many of their specific needs can be met by *configuration* of the existing system being proposed rather than by *customisation* of it. Configuration is the selection of existing functionality sets that a system can already provide by setting the relevant system parameters to appropriate values. Because existing functionality is being enabled that, at least in theory, has already been successfully developed and verified, the risk of unexpected system behaviour is theoretically relatively low. (Modern systems frequently have thousands of such parameters, every combination of which cannot realistically be verified in advance and many combinations of which make no sense in any event, and so this risk is never zero nor even as low as project parties like to assume.)

By contrast, customisation of a system is the addition of new functionality, or the modification of existing functionality, by developing new or amended system source code. Such changes not only need to be designed and implemented, but also tested and any material defects corrected, adding development risk to the project.

7 Prototypes & Simulations

When a significant proportion of a system can be constructed out of existing components and sub-systems, it becomes possible to build a prototype that can be used to quickly verify that the selected components and sub-systems are fit for the purposes of the project, and that they can be combined as anticipated to broadly achieve the project's high-level requirements.

Prototypes are also useful where there are a relatively small number of specific aspects of the required system that present the most design and/or development risk. Proof-of-concept (PoC) prototypes can be built that specifically prove (or disprove) the intended approaches, which can be particularly valuable when the final design of other aspects will significantly affect the design of other, less risky aspects of the system. Simulators are often used to model – in other words, to test and prove or disprove – a prototype's fitness for purpose during the design phase, and/or the final system's readiness during the verification and Acceptance phases.

8 Digital v physical

Construction Contractors inherently work with and deliver physical inputs and outputs, and consequently are almost always local, even when they are part of a much larger regional or global organisation. Systems Contractors, on the other hand, work largely with digital inputs and outputs, and as a result are able to deliver their goods and services to Customers across the globe. One of the most fundamental differences to Customers arising from these different postures is the need for construction Contractors to work within the constraints of their local markets – i.e., to be willing to accept market-standard contractual arrangements when they are not able to negotiate a better outcome. By contrast, systems Contractors are far more able and willing to mandate contractual arrangements on a largely "take it or leave it" basis, as they are able to enter and leave local markets far more easily than Construction Contractors when local market conditions do not align with their preferred risk profile. The extent to which a technology Contractor delivers a digital product – for example, a cloud project management service, as opposed to a human service – for example, integration of a project management system, determines directly their power in this regard. The more digital the product or service, the more the systems Contractor is able to dictate terms.

Where a systems integration Contractor is primarily integrating a digital service provided by a third party, they are thus generally unable to obtain back-to-back terms with their third-party subcontractor, and so may not be able to provide terms that Customers frequently desire as they lack meaningful control over or cover (via a back-to-back subcontract) for many of the risks the Customer will seek to flow down.

9 Intellectual Property Rights

As a result of the various factors discussed above, but most particularly because all modern technology systems comprise critical components and sub-systems that are provided by global third parties who are not willing to accept infrastructure-style risk allocations, it is unlikely that the standard intellectual property rights provisions that govern the rest of an infrastructure project will be effective if applied unchanged to its technology subcontracts.

In particular, the standard requirement to grant sub-licensable and assignable licenses is often impossible to comply with under the licenses commonly available for Commercial Off-The Shelf (COTS) software. This can lead to unexpected and unwelcome problems at Project completion, when the contractual obligation to provide such licenses simply cannot be met. Distinguishing between licenses for subcontractors' proprietary systems, for which the subcontractor is free to agree whatever license terms are mutually agreeable to the contract parties, and licenses for COTS systems, where the subcontractor has no such leeway, is frequently the only way to solve this issue. Similar issues and solutions apply to the common requirements for placing source code for key software systems in escrow, as well as for granting IP rights over design materials and other documentation deliverables.

Critical to effectively mitigating issues of "gap rights" as well as gap risk is identifying the core technology systems and subcontracts that are most important to the success of the overall project and putting in place an IPR regime that will ensure that the necessary rights and obligations are in place for those systems and subcontracts. A more standard infrastructure IPR regime can then be applied to the remainder of the IP relevant to the project and its operation.

For example, in a road PPP, the Operations Maintenance and Control System (OMCS) and associated Intelligent Transport Systems (ITS) subcontracts, and, if relevant, tolling systems subcontracts, are often key to the overall success of the project and its operation. Ensuring that there is an IPR regime for these key subcontracts that is successfully, and effectively, aligned from the Project deed all the way down to the OMCS, ITS and tolling subcontracts is an effective way of ensuring that the Project stakeholders really do receive both the rights and the obligations that they require to complete the asset and then operate it over its lifetime.

Failure to address these risks may create the illusion that the necessary rights have been obtained and allocated (because they are indeed assigned in the Project deed) when in effect the only actual allocation is of the risk that the necessary rights can never be obtained at all. This kind of risk is inevitably shared, rather than allocated; if an asset is found to be using one or more of its key operating systems without the required rights – e.g., under a license that is broader at the Project level than it is at the point that it is actually granted by the ultimate rights holder – then no commercially acceptable liability cap will support the potential costs that might arise. Perhaps the ultimate such risk is of a third-party IP rights holder whose IP has been infringed obtaining an injunction for the suspension of the operation of the asset whilst the infringement is rectified.

10 Requirements analysis and derivation

One result of the complexity common to technology projects is that the contractual requirements evolve as the parties unpack that complexity during the project and the Customer understands how their written requirements will result in unanticipated and often undesirable (to the Customer) outcomes. Indeed, some technology projects explicitly anticipate and prepare for this outcome, through clauses that formally replace the contractual Functional and Performance Specification with the Customer-approved Requirements that result from formal requirements analysis and derivation activities during the project's design phase.

Whether their contract takes this additional step or not, it is critical that the parties to technology contracts understand and take steps to deal with the complexity inherent in their own requirements. This has further implications for the concept of Completion and the associated level of acceptable Defects.

11 Practical Completion and Defects

A fundamental difference between infrastructure and technology projects is that infrastructure projects are inherently static in nature, while technology systems exist in a continuous state of flux.

A freeway is a largely static piece of infrastructure. It is designed to carry a prescribed amount of traffic at prescribed speeds, and subject to being properly constructed and maintained, is capable of remaining fit for purpose for decades.

Technology systems on the other hand are subject to the vagaries of consistent and ever accelerating advances in technology, correspondingly short first- and third-party product life-cycles, and the resulting inevitability of obsolescence.

This fundamental difference in life-cycle of the product being delivered results in stark differences between how Completion is viewed in an infrastructure project as opposed to a technology project.

In an infrastructure project Completion is binary. The piece of infrastructure is either complete (in the sense that it meets the prescribed specifications) or it is not.

In a technology project Completion can be much more elusive for a number of reasons. A first point of departure is that the specifications in an infrastructure project remain largely static, whereas in a technology project they can remain in flux and evolve considerably over time as the technology solution is developed to fit the project, on the one hand, and the Customer understands the implications of its own requirements and adjusts them accordingly, on the other hand. Completion as it's contemplated on signing of the contract is very likely not to be the same as Completion in its eventual form in a technology project.

A further point of departure is the recognition that a technology system is a continual work in progress. The solution at Completion is very often not the ultimate or eventual solution, but instead a robustly stable solution that serves as a foundation for a product that continues to be updated over months or even years. To accommodate this, technology contracts generally assume and require ongoing delivery of Updates and other improvements as part of the standard scope. This is a foreign concept in the construction world, where future improvements are always a specific and new scope of work.

Extensive use of globalised, third-party components contribute to both these aspects – the first, to correct defects in third-party components, and the second to respond to end-of-life and other major changes in direction in those third-party components that in turn necessitate updates to the primary first-party deliverables.

A final point of departure is the ever-present risk in technology projects of so-called "unknown unknowns" – issues that neither party is aware of or anticipates. Although "unknown unknowns"

arise in infrastructure from time to time, their prevalence in technology projects is far greater due to the complexity of the technology systems involved and the need to rely on and integrate multiple legacy third party systems, each with their own inherent, and often undiscovered flaws.

These very different approaches to defining the successful Completion of the Contractor's mandate inevitably result in conflict and misunderstanding when a constantly evolving technology solution is fused to or forms part of an immutable infrastructure project.

Bridging these very different sets of expectations requires a general understanding of the demands and limitations operating on each side and developing concepts of Completion which cater for the rigor required by infrastructure projects while maintaining the commercial and practical flexibility demanded by the technology component of the project.

12 Design and Operational Lives

The same trade-offs discussed above also apply to Design and Operational Lives of technology systems. Careful consideration must be given to how these requirements are flowed down from an infrastructure contracts to a technology sub-contract, as the technology system and its components are very unlikely to have design lives that can realistically be back-to-backed. This is particularly true in the case of commodity computing hardware, which unlike software simply cannot be operated indefinitely.

13 Consequences of failure

The consequences of failure are also often different for construction and technology contracts, at least in terms of the potential for re-use of deliverables provided by the Contractor prior to termination by the Customer of the contract.

In the event of project failure and consequent termination of a construction contract, the Customer will often be able to procure a new Contractor to complete the work already done, without needing to re-start the project from scratch. In particular, construction Contractors are familiar with the practice of Customers procuring a design before transferring responsibility (and liability) for that design to the construction Contractor prior to construction commencement. As a result, not only are construction Contractors familiar with the task of constructing a design provided by a different Contractor, and thus are far more replaceable than in technology contracts where design and implementation are usually inextricably integrated, but this separation of design and construction responsibilities to different Contractors (even where the design Contractor is or becomes a sub-contractor of the construction Contractor) also means that it may be possible to re-use an already completed design that is fit for purpose in the event that the construction Contractor proves not to be.

This is generally not the case with systems contracts, where both the design and the implementation are frequently not just bespoke but also proprietary. Further, the key deliverables are frequently largely digital, and thus there is often little or even no commodity hardware that can be effectively re-used by a new Contractor. As a result termination of a technology Contractor will generally

require that any replacement Contractor essentially commences a brand new project without effectively re-using any of the deliverables from the terminated contract.

This has obvious implications when determining the Contractor liability cap that will give the Customer sufficient protection in the event of failure by a Contractor to deliver a technology project, relative to the cap that is appropriate for a construction project.

The liability position is further complicated by the technology Contractor's inability to flow down liability to its key suppliers – the third parties that supply each of the components and sub-systems the Contractor's solution is built on. The provision of those technologies will each be subject to their own liability caps, likely to be much smaller than the overall cost of the larger technology project to implement a full system for the infrastructure project. This leaves two choices for the prime contractor – either accept an increased liability as the system integrator (which will leave a gap in cases where it is the sub-system that has failed) or try and limit liability to component parts of the system which may fail – a scenario which is rarely accepted by a Customer, and essentially never in the case of an infrastructure project. It is important to recognise that the technology Contractor, like every other party in the infrastructure project's contracting chain, is almost always a market taker and not a market maker in this regard.

14 Conclusion

There are many ways in which the risk profile for a technology project differs from an infrastructure one in general, and a PPP in particular. There are also numerous ways in which an infrastructure project can reduce the risk of a technology subcontract adversely affecting the success of the overall project, once the risk profile is understood and taken into account.

An appropriate and effective intellectual property regime is critical to the success of any PPP, but the standard IP regime that governs most of the project's IP is frequently not suitable for the core technology systems that will be critical to the success of the overall project. In order to minimise both gap risk and "gap rights" the core technology systems and their associated IP regimes should be identified and negotiated before the Project deed's IP regime is set in stone. Often, the use of two parallel IP regimes, one for the core technology systems and one for the remainder of the project's IP, is the most effective way to ensure that the Customer receives not just the optimum combination of IP rights and protections but also the most effective one.

Like many other aspects of a technology project, the intellectual property regime is further complicated by the prevalence of global suppliers in technology projects. Essentially, this makes every party in the infrastructure project contracting chain a market taker in important areas such as IPR and liability flow-downs, something that parties to infrastructure contracts are unused to and so rarely even realise – and consequently do not take into account. Getting these things right up front is the key enabler for putting effective contractual protections in place.

Modern technology systems are incredibly complex black boxes that are actually made up of surprisingly large numbers of sub-systems that are in turn each also incredibly complex black boxes. Many, if not most, of these sub-systems have the added complexity of being provided by third-parties to which the Project parties have very limited recourse. It is generally not commercially

viable – nor advisable, from a risk perspective – to develop a fully bespoke technology system for a single project; as a result, most subsystems are actually customised and/or configured for the purposes of a project, instead. Customising an existing system constrains development risk to the extent of the customisations; configuring an existing system (to the extent it can be configured instead) reduces it still further. However, designing a PPP's operating model and its associated processes with the desired system already in mind reduces this category of technology risk to its absolute minimum. This is not always an option, most particularly in the case of large, existing organisations, operating models and processes; however, in the case of a PPP, it can be one of the single most effective ways to minimise overall technology risk.

Technology projects usually have myriad decision points over the course of the project, and technology Contractors are accustomed to being directed by their Customers. They expect their Customers to own these decisions, and to recognise the commercial consequences of directions that expand or change the Contractor's scope.

The risks inherent in delivering any project of even the most basic complexity benefits from careful planning, but this planning is often disregarded by construction Contractors when subcontracting technology systems. Don't do this.

Complex systems are inherently difficult to predict, and experienced practitioners understand the limits of planning and the diminishing returns as plans grow more complex. Parties to technology projects should ensure they have clear, agreed, and realistic expectations when it comes to Acceptance, Practical Completion, and the treatment of Defects. Similar considerations apply to the Design and Operational Lives requirements that can realistically be met by commodity technology systems such as those used in infrastructure projects.

Finally, well-advised Customers will plan for success but be clear-eyed about the potential for failure, and consequently ensure they have suitable recourse when failure is due to their Contractor's breach. Termination will generally mean that the entire project must be restarted from the beginning when a new Contractor is identified and contracted, and so is even more of a last resort than it is for construction contracts.