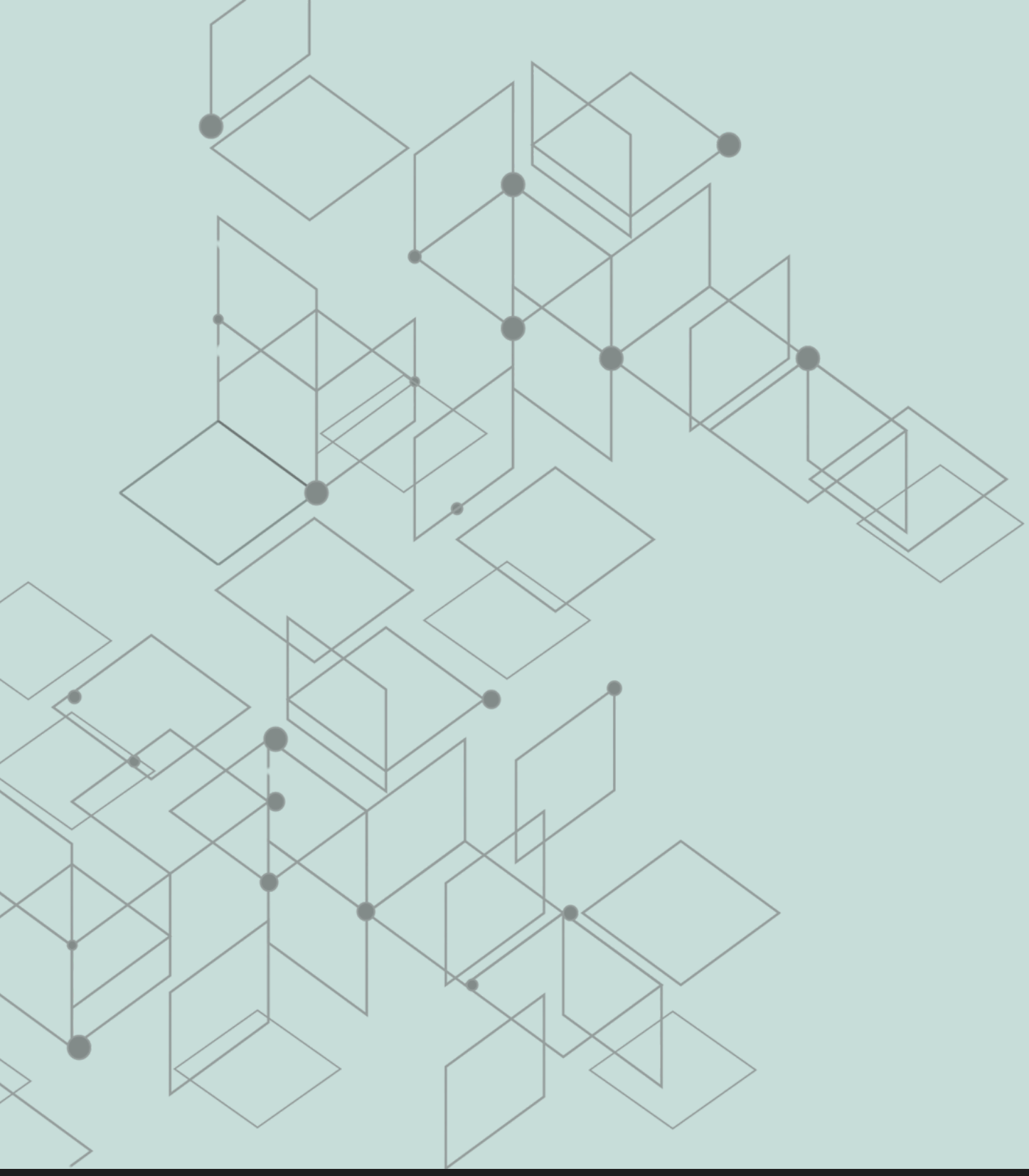

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AI ROI framework:

Quantifying the value of knowing earlier?

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Executive Summary

Organisations across every sector are under increasing pressure to identify where AI can create value. Some are evaluating new opportunities, some are building business cases for investment, and others are already deploying AI but struggling to quantify the return. In each case, the challenge is often the same: traditional ROI models were designed to evaluate automation, not intelligence.

Automation creates value through efficiency gains, reduced manual effort and lower operating costs. An AI intelligence layer creates value differently. Rather than replacing individual tasks, it sits above complex operations to improve the quality, timing and confidence of decisions. By helping organisations understand what is likely to happen earlier, it enables risks to be mitigated sooner, resources to be coordinated more effectively and investments to be planned with greater certainty.

The value created can be significantly greater than automation alone, but it must be evaluated differently. The benefits are often found in avoided disruption, faster resolution, improved coordination, higher asset utilisation and more effective capital allocation. To justify investment, organisations need frameworks that can identify, quantify and measure these outcomes in a structured and repeatable way.

This paper provides a practical three-layer framework for identifying, quantifying and measuring the value created by AI intelligence capabilities. Drawing on both published research and Entopy's experience deploying Unified Intelligence systems across complex infrastructure environments, it is designed to help leaders build credible business cases, align stakeholders and evaluate AI investments based on the outcomes they create rather than the technology itself.

- **Protect Value: reducing risk exposure and resolving disruption more efficiently.**
- **Create Value: improving productivity, resource utilisation and operational capacity.**
- **Direct Value: improving capital allocation, investment effectiveness and long-term strategic decision-making.**

Together, these layers provide a structured approach for identifying and quantifying the broader value created by AI intelligence capabilities. They demonstrate that the ROI of AI extends far beyond automation and labour savings, creating measurable value through better decisions, made earlier, across complex operations.

> **The ROI of predictive intelligence is not found in the prediction itself. It is found in the decisions made possible because the organisation understood what was coming early enough to act.**

THE THREE LAYERS OF VALUE

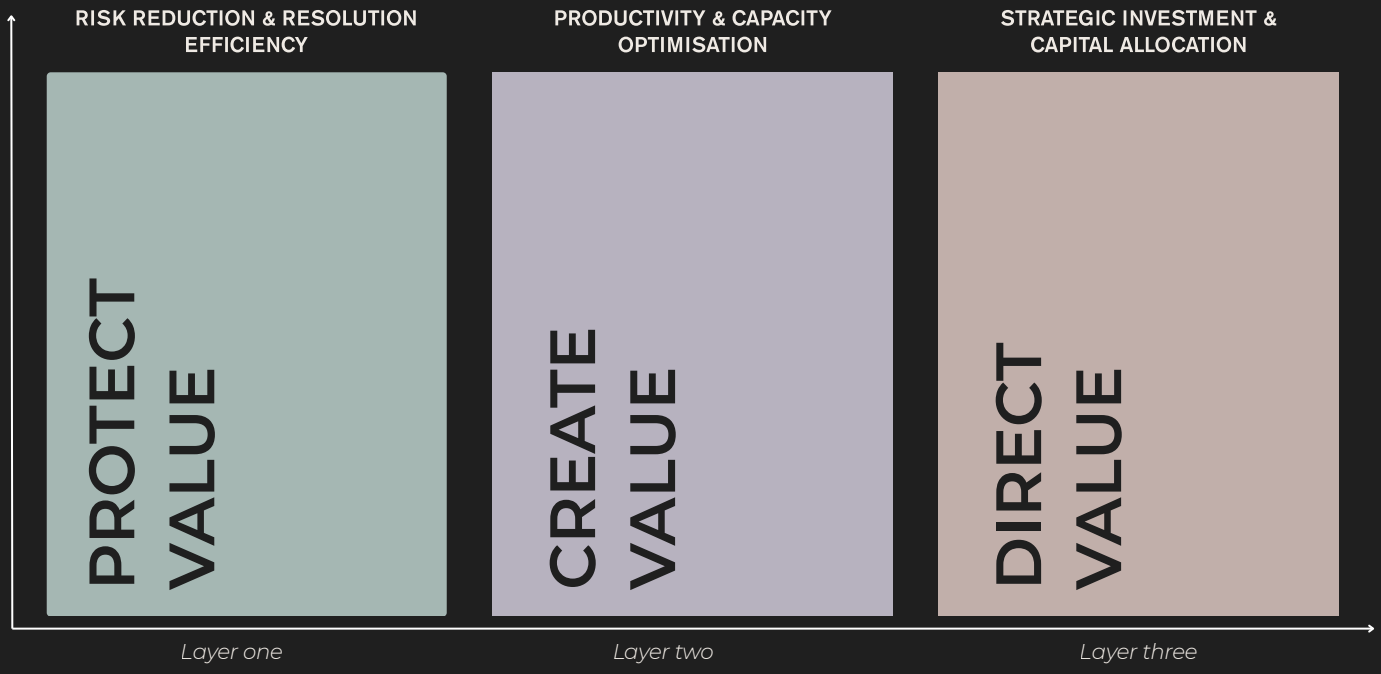
The primary role of an unified intelligence layer is to improve the quality, timing and confidence of decisions. It does this by helping organisations understand what is likely to happen, what the consequences may be and what actions are available before events unfold, across the full ecosystem or environment. While the operational use cases may vary, the value created typically falls into three interconnected layers.

The first is **Risk Reduction & Resolution Efficiency**. Earlier awareness of emerging risks gives organisations more time to act, more options to choose from and a greater likelihood of successful intervention. The result is reduced exposure to operational, financial and reputational consequences, alongside lower disruption and recovery costs when events do occur.

The second is **Productivity & Capacity Optimisation**. Better decisions enable organisations to coordinate people, assets and activities more effectively. This improves the utilisation of existing infrastructure and resources, allowing greater throughput, output and service delivery to be achieved without a proportional increase in cost.

The third is **Strategic Investment & Capital Allocation**. As operational performance improves, organisations can extract more value from existing assets and gain a clearer understanding of future requirements. This supports more effective investment decisions, improves capital allocation and can defer or reshape major capital expenditure by extending the useful capacity of the existing estate.

Together, the three layers provide a commercial lens for evaluating the value of AI. Protect Value asks how risk exposure and disruption costs can be reduced. Create Value asks how we can deliver more within existing estates. Direct Value asks how capital can be allocated more effectively and how existing infrastructure can be utilised for longer before additional investment is required.



Risk reduction & resolution efficiency.

The first component of this layer focuses on reducing exposure to operational risk. Across almost every environment, there is a period of time between a risk beginning to emerge and its consequences becoming unavoidable. The earlier an organisation understands what is likely to happen, the greater its opportunity to influence the outcome.

This principle is evident across many domains. Early flood warning systems, for example, create value not because they stop floods occurring, but because they provide enough warning for people, assets and resources to be protected before the event takes place. The same principle applies across complex operations. Earlier awareness increases optionality, allowing organisations to prioritise emerging risks, implement mitigation measures and reduce the likelihood that a potential issue develops into a significant operational consequence.

In practical terms, the value created depends on three factors: the potential consequence if the event occurs, the proportion of that consequence that can realistically be mitigated through earlier intervention (the Actionability Factor), and the likelihood that the mitigation will be successful (the Mitigation Success Rate). Together, these variables provide a practical framework for quantifying the value of risk reduction through earlier awareness.

Worked example

A ferry port is preparing for a busy summer day. Passenger demand forecasts are already high and operators are aware of a system issue that has reduced processing capacity. On its own, neither factor is considered critical. However, changing weather conditions are causing passengers to arrive earlier than expected, rail disruptions are increasing road traffic volumes, and unusually warm temperatures are driving additional demand.

These factors are assessed independently. By 09:00, congestion begins to develop and operators recognise that the situation is escalating. Intervention is still possible, but the available options are now limited. Additional resources can be deployed and processes adjusted, but queues have already formed, customer impacts are visible and disruption is becoming increasingly costly to resolve.

With a Unified Intelligence capability, the interaction between demand forecasts, arrival profiles, weather conditions, transport network disruption and operational performance is continuously assessed. Several hours earlier, the system identifies a high likelihood of severe congestion during the morning peak. Operators can intervene before disruption occurs, with a broader range of options available. Resources can be repositioned and contingency measures implemented in a controlled manner, reducing the likelihood that congestion develops in the first place.

The disruption itself is not avoided. The value comes from understanding the likely consequence early enough to influence it. Earlier awareness increases optionality, improves the probability of successful intervention and reduces the operational, financial and reputational cost of the event.

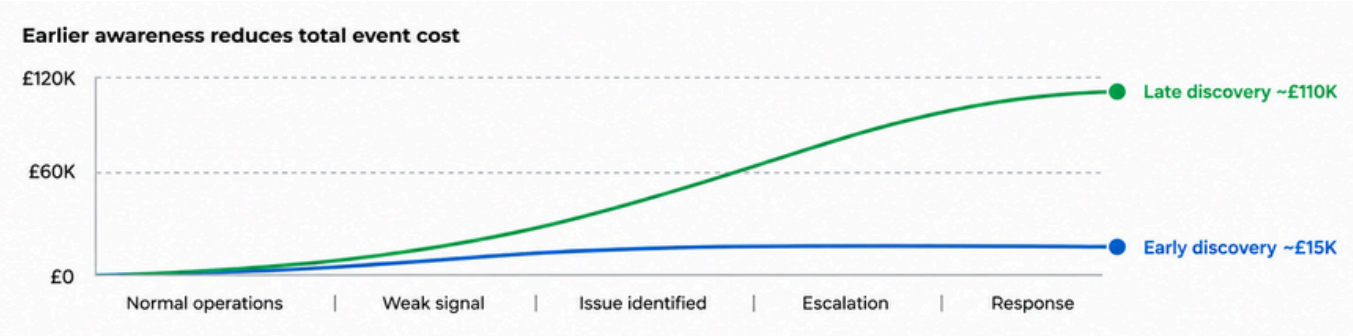
Risk Reduction Value = Operational Consequence × Actionability Factor × Mitigation Success Rate

Metric	2 Hour Warning	10 Hour Warning
Potential consequence	£500,000	£500,000
Actionability Factor	25%	75%
Mitigation Success Rate	50%	80%
Risk Reduction Value	**£62,500**	**£300,000**

The second strand of this layer focuses on reducing the cost of response when disruption occurs. While earlier awareness can reduce exposure to risk, not every disruption can be avoided. However, even when the outcome remains broadly the same, earlier understanding provides more time, more options and greater control over the response.

The value is therefore not only found in reducing the likelihood of disruption, but also in reducing the operational, financial and reputational cost of managing it.

The worked example on the previous page illustrates this well. In both scenarios, the underlying issue occurs. The difference is not whether disruption happens, but how it is managed. Earlier awareness provides organisations with more time, more options and greater control over the outcome. As a result, interventions can be implemented in a more coordinated, efficient and cost-effective manner.



The graph illustrates this principle well. The blue line shows earlier awareness resulting in a smoother, more controlled and less costly operational response. The green line shows delayed awareness, the build-up of operational inefficiencies and the eventual intervention required to restore stability. The outcome may ultimately be the same, but the cost of getting there is significantly higher.

To calculate this value, we need to think slightly differently from the first calculation because the event itself has already occurred. What changes is our awareness of what is likely to happen and our ability to make better decisions as a result. The objective is therefore to understand the economic value of acting earlier and with greater certainty.

To do this, organisations should identify the cost lines associated with a given operational scenario and compare the costs of earlier intervention against later intervention, ideally using historical operational data to support the analysis. For example:

Cost Category	Early Action	Late Action
Customer compensation & remediation	£3,000	£20,000
Additional staffing & overtime	£3,000	£10,000
Operational recovery & coordination	£3,000	£20,000
Service performance impacts	£4,000	£35,000
Reputation & stakeholder management	£2,000	£25,000
Total cost of response	**£15,000**	**£110,000**

Resolution Efficiency Value = Cost of Late Resolution – Cost of Early Resolution

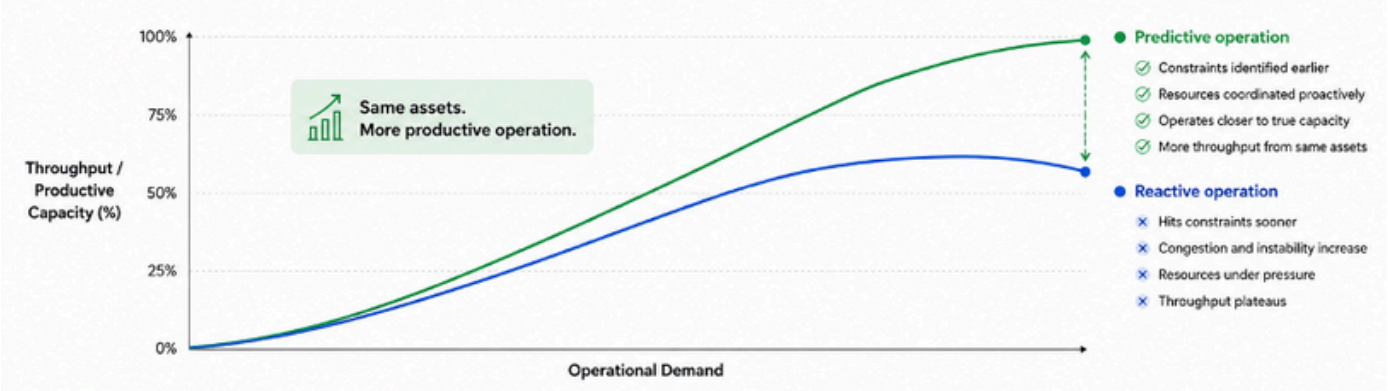
LAYER 2

Productivity & capacity optimisation.

The second layer of value comes from improving the utilisation of existing assets and resources. Across most critical infrastructure environments, demand continues to grow while resources remain constrained. Infrastructure, equipment and operational teams can only support a finite level of throughput before capacity limits are reached.

This layer focuses on using a Unified Intelligence Layer to improve productivity and operational efficiency within the existing estate. By improving awareness, communication and planning, organisations can make better decisions about how scarce resources are deployed.

This may involve pooling resources across organisational boundaries, prioritising the activities that deliver the greatest value, or dynamically reallocating assets in response to changing conditions. The result is better coordination of assets, people and activities, allowing more value to be extracted from infrastructure that already exists. Rather than increasing resources, organisations increase the effectiveness of the resources they already have, creating additional throughput and capacity from the same underlying asset base.



From an economic perspective, this is primarily an OPEX conversation. Rather than reducing operating costs directly, the objective is to increase the amount of output generated from the same operating cost base. More passengers, vessel calls, train movements, megawatts, litres treated or tonnes processed can be delivered without a proportional increase in expenditure.

In practical terms, organisations improve the productivity of existing assets and resources. The cost of operating the estate remains broadly unchanged, but the value generated by that estate increases. This lowers the operating cost per unit of output and improves the overall return on operational expenditure.

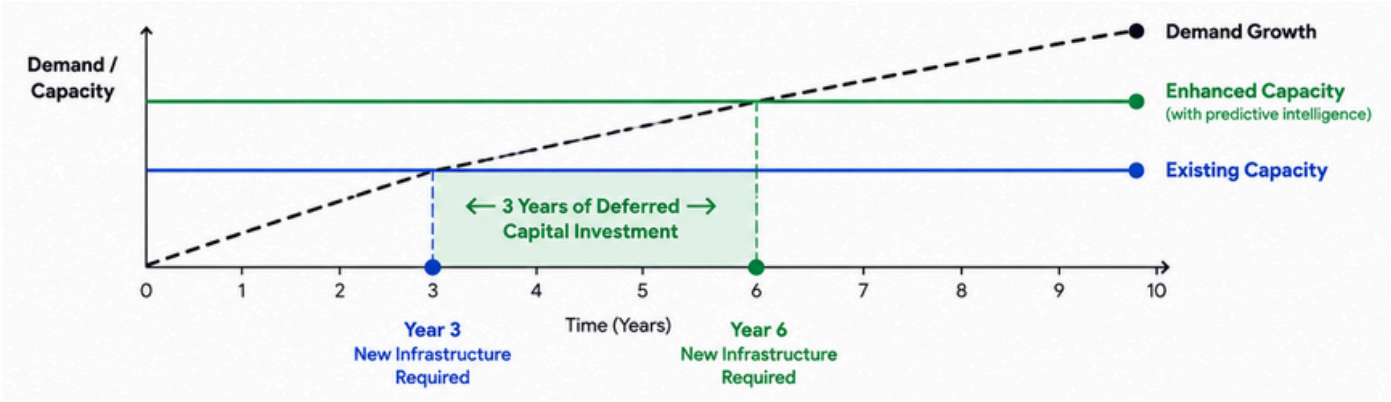
The calculation for this layer focuses on additional throughput. If an organisation is able to service more units, it should calculate the number of additional units delivered and the contribution generated per unit.

Productivity Value = Additional Throughput × Contribution per Unit

The second strand of this layer focuses on extending the useful capacity of existing infrastructure and assets. While the previous section concentrated on increasing throughput and productivity, the consequence of those improvements is often that organisations can accommodate growing demand without immediately investing in additional capacity.

Across most infrastructure environments, major capital investments are driven by forecast demand exceeding available capacity. New berths, terminals, substations, vessels, rolling stock, treatment facilities or workforce expansion are typically justified because existing assets are believed to be approaching their operational limits.

However, these capacity assumptions are often based on how assets are currently being utilised rather than how effectively they could be utilised. By improving awareness, coordination, prioritisation and planning across an operation, a Unified Intelligence Layer can help organisations extract greater value from existing infrastructure before additional investment becomes necessary.



This may be achieved through better coordination across a network, more effective deployment of resources, improved scheduling, or identifying and removing operational bottlenecks that constrain overall performance. In many cases, the result is that existing assets can support higher levels of demand than previously assumed.

The value created is therefore not only found in additional throughput, but also in extending the useful capacity of the existing estate. Where planned investments are intended primarily to increase capacity, organisations may be able to defer those investments for several years while maintaining the desired level of service.

This creates two forms of value. First, it reduces the cost of capital where investment would otherwise have been debt-funded. Second, it frees up capital that can be allocated to other strategic priorities or higher-return opportunities elsewhere in the organisation.

Capital Deferral Value = Deferred Investment × Cost of Capital × Years Deferred

LAYER 3

Strategic investment & capital allocation.

The third layer focuses on strategic investment and capital allocation. While the first two layers concentrate on improving operational performance, this layer focuses on improving the quality of long-term decisions. In this context, a Unified Intelligence Layer provides leaders with a continuously updated understanding of how an operation behaves today and how it is likely to behave in the future.

Major infrastructure investments are often justified by perceived capacity constraints, operational challenges or future demand forecasts. However, these decisions are typically made using incomplete information and static assumptions. As a result, organisations can invest in the wrong assets, invest too early, or fail to address the true constraint limiting performance.

A Unified Intelligence Layer changes this dynamic. By combining a live operational picture with advanced AI reasoning, organisations can assess, analyse and war-game future scenarios before capital is committed. This allows leaders to understand how different investments influence operational outcomes, test alternative strategies and identify the interventions that create the greatest system-wide benefit.

Worked Example: Selecting the Right Investment Strategy.

A wastewater operator must improve network performance to meet regulatory requirements and support future population growth. Three investment options are under consideration: Expanding treatment capacity at a major wastewater treatment works (£120m); constructing additional stormwater storage (£80m), or upgrading pumping stations and network controls (£25m)

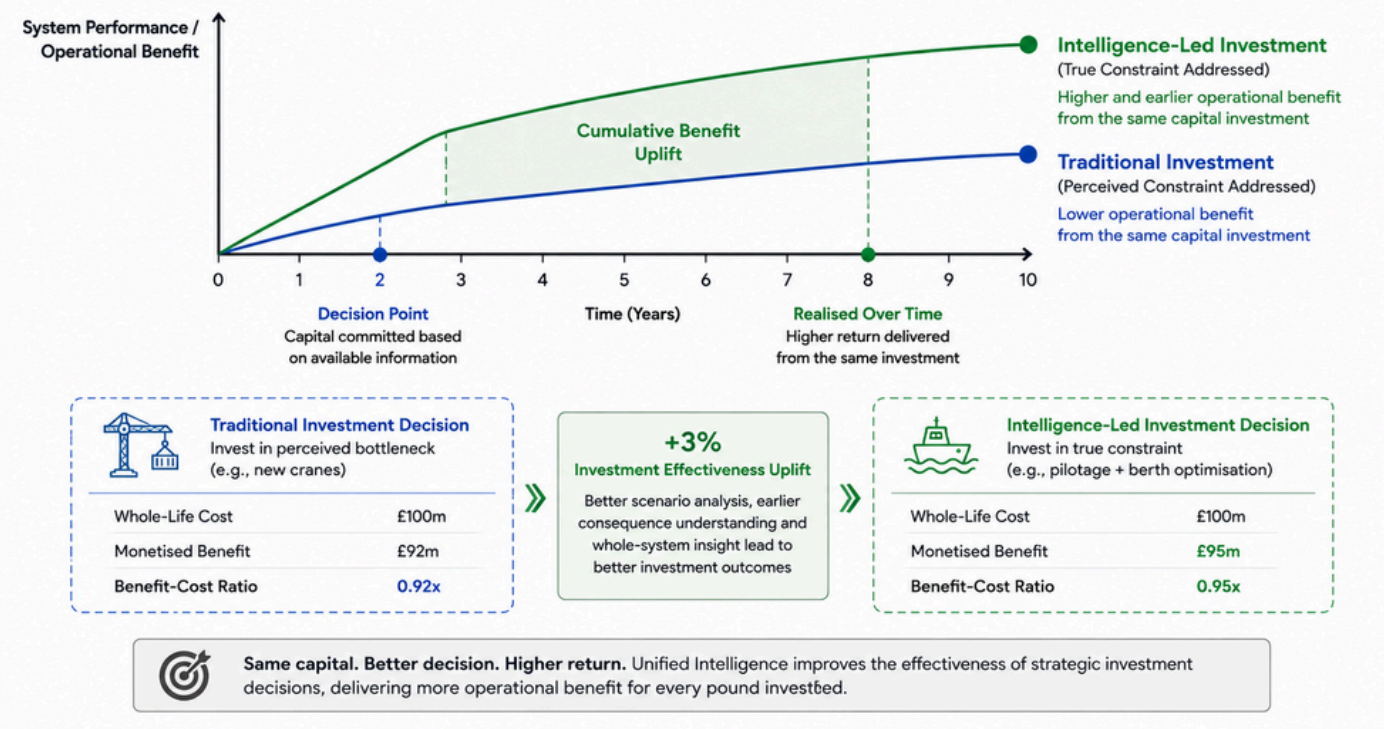
Traditionally, investment decisions would be based on historical performance, engineering studies and demand forecasts. Using a Unified Intelligence Layer, the operator models future growth scenarios, rainfall patterns, network behaviour and asset interactions across the entire catchment.

The analysis reveals that treatment capacity is unlikely to become the primary constraint for at least ten years. Instead, network bottlenecks and storage limitations are responsible for the majority of future performance risks. As a result, the operator prioritises targeted storage and network improvements rather than treatment expansion.

The value is not that capital investment was avoided. The value is that capital was allocated to the intervention that delivered the greatest long-term benefit.

The value of this layer is therefore not simply better forecasting. It is better capital allocation. Investments are directed towards the areas that create the greatest operational and economic return, reducing the likelihood of misallocated capital and improving the overall effectiveness of investment programmes.

The concept is illustrated in the graph below, which compares a traditional investment decision against an intelligence-led investment decision. In practice, value may be created through selecting a better investment, improving the timing of investment, or increasing the operational benefit generated from the same capital expenditure.



The value of a Unified Intelligence Layer is not that it helps organisations spend less money, but that it helps them spend money more effectively. By understanding how assets, resources and constraints interact across the wider system, leaders can identify the interventions that will create the greatest operational benefit. The result is better capital allocation, higher returns from investment and improved long-term performance from the same capital expenditure.

Strategic Investment Value = Whole-Life Investment Cost × Investment Performance Uplift

Ok, so where should you start?

Unified Intelligence creates value by improving the quality, timing and confidence of decisions. By helping organisations understand what is likely to happen earlier, it reduces risk, improves operational efficiency and supports better investment decisions. These benefits are cumulative: reducing disruption often improves productivity, improved productivity can extend capacity, and extended capacity can influence the timing and effectiveness of capital investment. As a result, a single intelligence capability can simultaneously protect value, create value and unlock value.

However, organisations should focus their initial deployment on a single value layer. Attempting to pursue every benefit at once can dilute focus and make success harder to measure. Instead, identify the most important operational challenge or strategic objective and use the intelligence capability to solve that problem first. Once established, the same capability can often create value across the other layers.

If your priority is...	Start with...
Reducing operational disruption	Protect Value
Increasing throughput from existing assets	Create Value
Improving operational coordination	Create Value
Managing operational risk	Protect Value
Considering a strategic investment	Unlock value

While deployment should focus on a single value layer, investment decisions should consider a broader range of outcomes. Most successful business cases are justified through a primary value driver: the operational challenge or strategic objective that the intelligence capability is intended to address. However, because intelligence improves decision-making across an entire system, additional ancillary benefits often emerge elsewhere in the organisation.

The framework on the following pages provides a structured approach for identifying the primary value driver, quantifying its value and recognising ancillary benefits that contribute to the overall return on investment.

Step 1: Identify the primary value driver

Primary objective	Value layer
Reduce disruption and operational risk	Protect Value
Increase throughput and productivity	Create Value
Improve capital efficiency and planning	Unlock Value

Step 2: Quantify the primary value

Primary Objective	Calculate value per event/instance
Protect Value	Risk Reduction Value + Resolution Efficiency Value
Create Value	Additional Throughput × Contribution per Unit
Direct Value	Stratgic Investment Value

Step 3: Recognise ancillary benefits

Ancillary value should be included because improvements delivered through the primary use case often create secondary benefits across operational performance, productivity and strategic investment decision-making.

Step 4: Illustration

Value stream	Calculation	Annual value
Primary Driver: Protect Value	Risk Reduction Value + Resolution Efficiency Value	£xxx
Ancillary: Create Value	Additional Throughput × Contribution per Unit	£xxx
Ancillary: Direct Value	Stratgic Investment Value	£xxx
Total Annual Value Created		**£xxx**

WORKED EXAMPLE

Scenario

A container shipping company is experiencing repeated schedule disruption across a major European service. Vessel delays, berth uncertainty, tidal constraints and port congestion are creating knock-on effects across the network.

Step 1: Primary value driver

Business issue	Primary value layer
Repeated disruption across port calls causing delay, fuel burn, replanning and customer impact	Protect Value

Step 2: Quantify primary value

Risk Reduction Value = Operational Consequence × Actionability Factor × Mitigation Success Rate

Metric	Value
Relevant elevated-risk port calls per year	80
Average consequence per high-risk event	£250,000
Actionability factor from earlier warning	40%
Mitigation success rate	60%
Average risk reduction value per event	£60,000
Annual risk reduction value	**£4.8m**

Resolution Efficiency Value = Cost of Late Resolution − Cost of Early Resolution

Metric	Value
Relevant disruption events per year	40
Average late resolution cost	£90,000
Average early resolution cost	£35,000
Average value per event	£55,000
Annual resolution efficiency value	**£2.2m**

Step 3: Quantify ancillary value

Create value

Productivity Value = Additional Throughput × Contribution per Unit

Metric	Value
Additional container moves enabled through better schedule reliability	15,000 TEU
Contribution per TEU	£80
Annual Create Value	**£1.2m**

Direct value

Strategic Investment Value = Whole-Life Investment Cost × Monetised Benefit Ratio × Investment Performance Uplift

Metric	Value
Whole-life investment programme influenced	£100m
Monetised benefit ratio	92%
Investment performance uplift	3%
Direct Value	**£2.76m**

Step 4: Illustration

Value stream	Type	Annual value
Protect Value	Primary driver	**£7.0m**
Create Value	Ancillary value	**£1.2m**
Direct Value	Ancillary value	**£2.76m**
Total value created		**£10.96m**
Annual cost of intelligence layer		**xxx**
Net annual benefit		**xxx**
ROI		**xxx%**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