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TECHNICAL WHITEPAPER

AI-Powered Bid & Tender Management

A reference architecture for the Opportunity-to-Quote lifecycle in the Oil & Gas and Energy sector, unifying AI-driven requirement elicitation, application lifecycle management, and product lifecycle management into a single, traceable bid-to-award pipeline.

DRIM AI · **Polarion ALM** · **Teamcenter PLM**

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1. Executive Summary

In capital-intensive industries — oil & gas, energy, and the engineering, procurement, and construction (EPC) firms that serve them — the bid-and-tender phase is where margin is won or lost. It is also, paradoxically, the least digitized stage of the engineering lifecycle. Long after design, manufacturing, and execution have been instrumented with sophisticated PLM and ALM platforms, the front end of the funnel — the Opportunity-to-Quote process — still runs on manual document handling, email threads, and disconnected spreadsheets.

The mechanics are unforgiving. A single tender package can comprise hundreds of pages of heterogeneous customer documentation: requirement specifications, datasheets, bills of materials, drawings, and composite PDFs that bundle several of these together. Bid teams must read, decompose ("shred"), and assess every clause against internal standards and industry codes, determine compliance, and price the engineering effort, often under aggressive deadlines and across thousands of concurrent opportunities. The cost of doing this manually is measured not only in labor, but in slow quote turnaround, inconsistent compliance assessment, and the loss of engineering judgment when an opportunity transitions to an awarded project: the team rebuilds analysis it has already done once the deal is won.

This whitepaper presents a reference architecture that closes that gap. It integrates three complementary platforms into a single-governed pipeline:

- **DRIM AI** — an AI-driven document-understanding and requirement-elicitation engine that converts unstructured customer files into structured, validated requirement objects with a human always in the loop.
- **Polarion ALM** — the requirements system of record and orchestration layer, holding the authoritative work-item structure, workflows, traceability, and the integration logic that binds the surrounding systems together.
- **Teamcenter PLM** — the authoritative repository for customer package files and the downstream engineering backbone into which validated requirements are published.

Two enterprise systems bookend the flow: a CRM platform originates the commercial opportunity, and a project master-data system (Project Management Software) governs awarded-project identity. The result is a continuous, auditable path from raw RFQ to validated quote to awarded project, deployed incrementally in phases to control risk.

> **KEY TAKEAWAY**
> *The opportunity is not to replace human engineers with AI, but to remove the document-handling tax that prevents them from doing engineering. The architecture treats AI as an accelerant inside a governed, traceable lifecycle, not as an unsupervised author of record.*

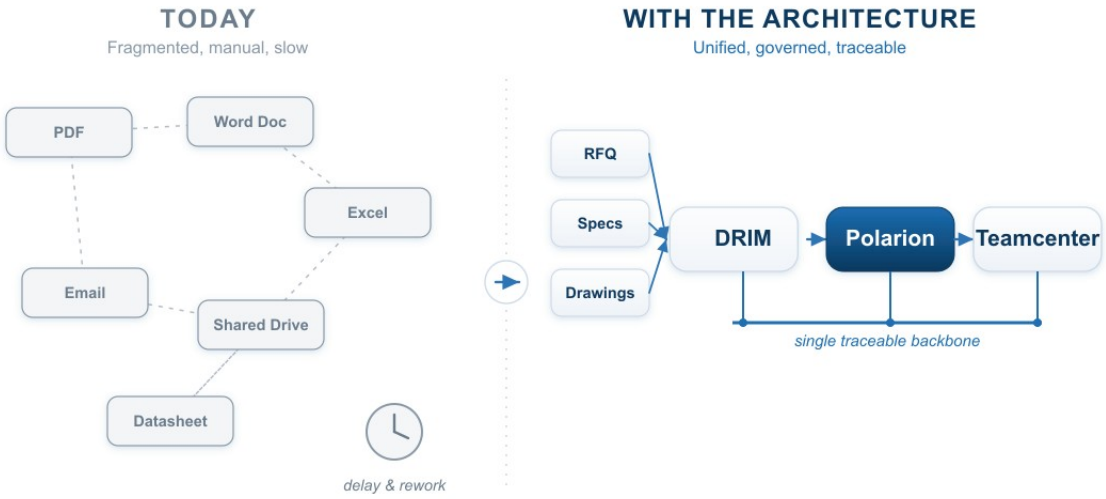

Figure 1. *From a fragmented, manual bid process to a unified, traceable pipeline.*

2. Introduction & Context

2.1 The competitive reality of capital-project bidding

Energy and process-industry projects are won on the quality and speed of the proposal. Customers issue tenders defined by dense requirement documents that reference established industry codes — ASME, API, PIP, ISO 9001 and others — and they expect bidders to demonstrate, clause by clause, how they will comply. The bidder who can assess a package faster, price it more accurately, and substantiate compliance more credibly holds a structural advantage. Yet the work of reading and decomposing those packages remains stubbornly manual.

The challenge is compounded by scale. A large engineering enterprise operates multiple business units, each with its own naming conventions, attribute models, and regional structures. Project master data alone can involve tens of thousands of records refreshed daily — in one representative deployment, a master-data feed delivered on the order of 15,000 project records per day across roughly 48 attributes per project. Any solution that addresses the bid lifecycle must therefore be designed for volume and for heterogeneity from the outset.

2.2 Two lifecycles, one continuum

It is useful to separate the front-end commercial lifecycle from the execution lifecycle, because they have different owners, cadences, and data characteristics:

- **Opportunity-to-Quote** (the bid/tender phase) — pre-sales work performed on an opportunity that may or may not be won. Requirements are in flux, customer documents arrive in batches, and engineering effort is speculative.
- **Order-to-Cash** (the execution phase) — work performed on an awarded project, where requirements are firm and traceability obligations are at their strictest.

These are not separate worlds; they are two phases of one continuum. A defining requirement of the architecture is that engineering performed during bidding must survive the transition to execution without re-keying or loss of context. Critically, the relationship is one-to-many: a single won opportunity can spawn multiple execution projects, and the data model must represent that fan-out explicitly.

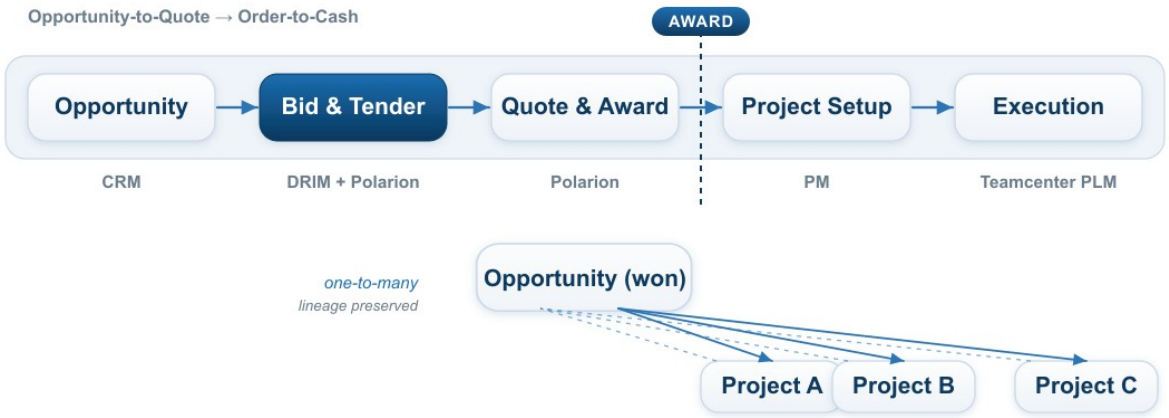

Figure 2. *The opportunity-to-project continuum, with the owning system beneath each phase and the one-to-many fan-out on award.*

2.3 The stakeholders and the data they create

The bid lifecycle is inherently cross-functional. A prospective customer supplies the source documents; a bid team coordinates the response; an estimation team prices it; and engineering provides the technical assessment, clarifications, and cost adders that determine whether the bid is competitive. Each interaction generates data — comments, compliance determinations, clarifications, cost adders — that today is frequently trapped in personal files and email, invisible to the next opportunity and unavailable for reuse.

> **KEY TAKEAWAY**
> *The strategic problem is not a shortage of tools. It is the absence of a connective tissue that captures the bid team's judgment as structured, reusable, traceable data, and carries it intact from opportunity to award.*

3. Core Technical Challenges

Before describing the solution, it is worth being precise about the technical and operational bottlenecks that any credible architecture must resolve. The following are the recurring failure modes observed across the bid-and-tender lifecycle, ordered roughly as they appear in the flow.

3.1 Heterogeneous, unstructured document intake

Customer packages do not arrive in a single, predictable shape. They span fully segmented requirement specifications, datasheets expressed as unstructured tables, complex data not

organized in row-centric form, multi-worksheet Excel workbooks (each sheet a different data source), drawing-only files, bills of materials, and composite PDFs that combine several of these. Some file types — native CAD drawings, for example — cannot be processed by document AI at all and must be handled through a separate manual path. The intake layer must recognize each case and route it appropriately, because a one-size-fits-all parser silently drops information.

Customer file case	Characteristics	Handling consideration
Fully segmented requirements	All content recognized as headings / requirement objects	Map directly to requirement objects with attachments
Requirements + datasheet tables	Unstructured tabular data embedded in PDF/Word	Capture tables within a requirement object's rich text; confirm completeness
Complex, non-row-centric data	Formulas, transposed or columnar sources	Requires structural interpretation, not naive row mapping
Multi-sheet Excel workbooks	Each worksheet has a distinct data source	Define per-sheet processing rules; charts/dashboards out of scope
Drawing-only files	Text embedded in PDF or as images	Often manual; native CAD handled outside document AI
Bills of materials / deliverable lists	Lists of required deliverables	Capture as requirement objects; reconcile against package
Composite PDF	A bundle of several of the above cases	Decompose into constituent cases before extraction

Table 1. A taxonomy of customer file cases the intake layer must distinguish.

3.2 Requirement elicitation at scale, at the right granularity

Once a document is understood, the requirements within it must be isolated as discrete work items: not too coarse (a whole datasheet collapsed into one object) and not too fine (a single requirement fragmented across page breaks). This is judgment-heavy work. The system must propose candidates and then let an engineer merge fragments that span pages, split blocks that conflate multiple requirements, and capture constraints hidden in headers or titles that an automated pass would discard. Doing this well, at the volume of a real tender, is the single largest source of manual effort in the current state.

3.3 The single-source-of-truth problem

Customer-supplied text is a contractual artifact. It must never be silently overwritten. Yet the engineering response (exceptions, clarifications, amended language) must be captured alongside it and made visible. The architecture must therefore enforce a strict separation between read-only source text and proposed/amended text, so that both the customer's request and the bidder's response coexist without ambiguity. Without this discipline, the audit trail collapses and the organization cannot defend what it actually committed to.

3.4 Compliance and standards management

Requirements reference external codes that themselves evolve. A project may cite a revision of a standard that is no longer current or introduce deviations that must be tracked and approved. The system must maintain a master list of applicable standards (including revision and deviation status) and actively flag when a project references a revision that differs from the controlled baseline. Treating external specifications as first-class, version-controlled objects is materially different from treating them as free text.

3.5 Order of precedence and conflict resolution

Real tenders contain conflicting requirements: a customer specification, an API standard, an internal guideline, and a regulatory code may all speak to the same parameter with different values. The organization needs a configurable order of precedence, tiered by source, so that conflicts are detected, surfaced for review, and resolved consistently, with the rationale recorded. Precedence is not a cosmetic ranking; it must be enforced through to downstream systems, or the same conflict will be re-litigated at every stage.

3.6 File mobility at enterprise scale

Customer files are large and numerous, and the same file must be visible to the PLM repository (as the source of truth) and to the AI layer (for processing) without proliferating uncontrolled copies. Moving files by hand does not scale, and intermediate storage introduces both cost and governance risk. The transfer mechanism must therefore stream files as data in motion, with no intermediate staging, and must load-balance by total payload size, individual file size, file count, and concurrent request count to remain stable under burst load.

3.7 Governance, roles, and the audit trail

Finally, every action must be attributable. Regulated and contractually exposed organizations need to know who changed what, when, why, across role boundaries (engineer, lead engineer, project manager, business operations, document administrator) and across project boundaries. Notifications must be event-driven, and personal work queues must surface exactly the items each user is responsible for. A bid lifecycle without a defensible audit trail is a liability, not an asset.

> **KEY TAKEAWAY**
> *Each of these seven challenges is individually solvable. The architecture's contribution is to solve them together, on a single backbone, so that fixing one does not break another.*

4. The Solution Architecture

4.1 Architectural philosophy

The architecture rests on four principles, each of which directly answers a challenge from the previous section:

1. **Clear systems of record.** Each class of data has exactly one authoritative owner. Customer files are owned by PLM; requirement objects and workflow are owned by ALM; commercial opportunity data originates in CRM; awarded-project identity is governed by the project master-data system. The AI layer is an elicitation engine, not a system of record.
2. **Human-in-the-loop AI.** AI proposes; people dispose. No requirement enters the project scope without explicit human validation, and the system makes that validation step a first-class, visible state.
3. **Traceability by construction.** Links, lineage, and history are produced as a by-product of the normal workflow, not bolted on afterwards. Every object carries its provenance.
4. **Files as data in motion.** File transfer between systems is a controlled stream with no intermediate storage, governed by explicit load-balancing parameters.

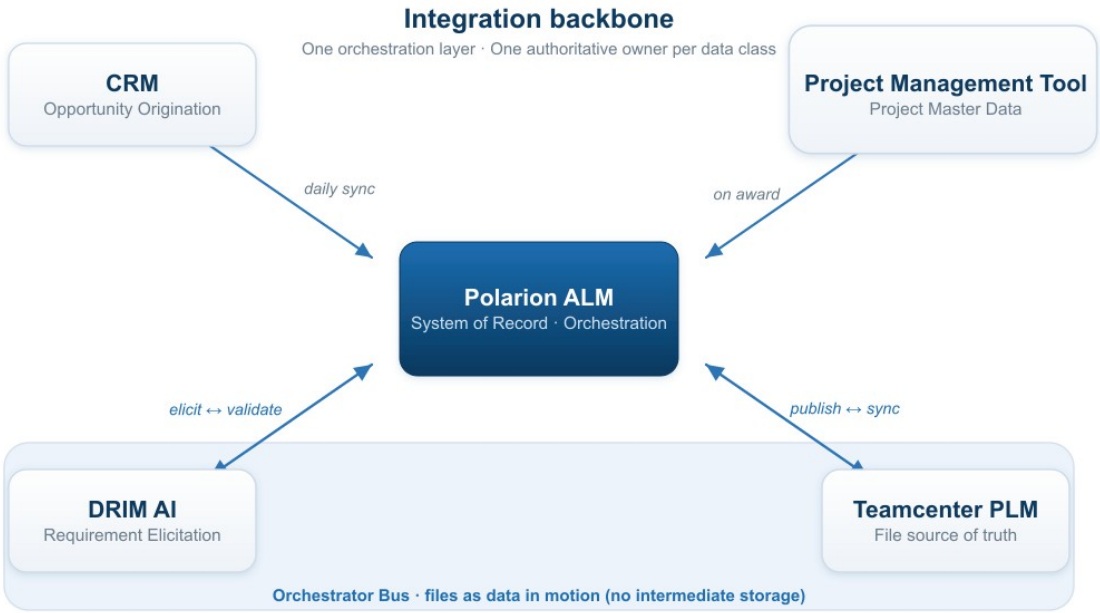

Figure 3. *The integration backbone: Polarion orchestrates DRIM, Teamcenter, the CRM, and the project master-data system over an Orchestrator Bus.*

4.2 The three pillars

DRIM AI — document understanding and elicitation

DRIM performs the work that precedes requirement engineering. Its document-understanding pipeline first normalizes the source: searchable PDFs are recognized and left intact, while Word documents are converted to a stable read-only PDF base to give every source a consistent, immutable reference layer, and OCR is applied only where genuinely needed. A layout-detection pass then extracts headers, footers, tables, and headings so that the document's structural hierarchy, and therefore the context of each requirement, is preserved rather than fragmented. A semantic pass identifies topics, criticality, and compliance signals, allowing engineers to immediately filter to high-impact content.

From this foundation DRIM proposes requirement candidates. Proposed-but-unvalidated candidates exist as non-active “shallow” objects, visually distinct from validated ones. When an engineer validates a candidate, it transitions to an active state and enters a publishing queue whose status is observable as data is pushed to the ALM. A manual-override capability lets engineers capture constraints the model overlooked (for instance, a hidden technical requirement embedded in a title) by promoting arbitrary text to a requirement object. Source text remains read-only; the engineering response is entered as proposed text mapped to a dedicated amended-text field, preserving the single source of truth.

DRIM also governs revisions. A revision center uses percentage-match semantics to classify changes between document versions: a high-but-imperfect match might indicate a simple value change (“30 days” becoming “15 days”) flagged for review, while a 100% match permits bulk transfer of prior assessments without re-review. Lineage between versions is preserved through a family-identity concept and a refines / refined-by link, so an engineer can always navigate from a version-2 requirement back to its version-1 origin. A standard-comments library, managed per business unit, lets the organization reuse curated comment text across opportunities, and a forward-looking link-prediction capability is on the roadmap to eventually propose requirement-to-requirement links automatically.

Polarion ALM — system of record and orchestration

Polarion holds the authoritative requirement structure and the logic that coordinates the surrounding systems. A commercial opportunity is represented as an Opportunity work item that acts as the proxy for the CRM opportunity and mirrors its status; its custom fields carry the commercial and segmentation attributes (opportunity identifier, stage, scope, market segment, line of business, and the export-classification handling the domain requires). Validated requirements live as work items (requirement objects, design requirements, engineering file objects, and formal text) inside Polarion Live Documents, under a workflow engine that records who changed what and when.

Polarion is also the orchestration layer. An Orchestrator Bus, implemented as a servlet plugin, acts as functional middleware between PLM files and the AI layer, calling each system through its native API. Reporting is a core capability: a compliance matrix, an opportunity-workspace document matrix that reconciles required specifications against those actually present (surfacing missing documents), and project- and opportunity-level dashboards give the bid team a live view of completeness and status. On the precedence problem, Polarion carries precedence as custom fields at the document and requirement level and reports objects by precedence tier, so conflicts are visible and governed rather than implicit.

Teamcenter PLM — file source of truth and downstream backbone

Teamcenter is the authoritative repository for customer package files and the destination into which validated requirements are published for downstream engineering. The architecture uses the released, direct Polarion-to-Teamcenter integration rather than a bespoke connector and associates each published document with its opportunity or project container based on published attributes carried on every requirement object. Change requests and their relationships are maintained across the ALM–PLM boundary through standard link mechanisms, so that the requirement structure visible in PLM stays consistent with the system of record in ALM.

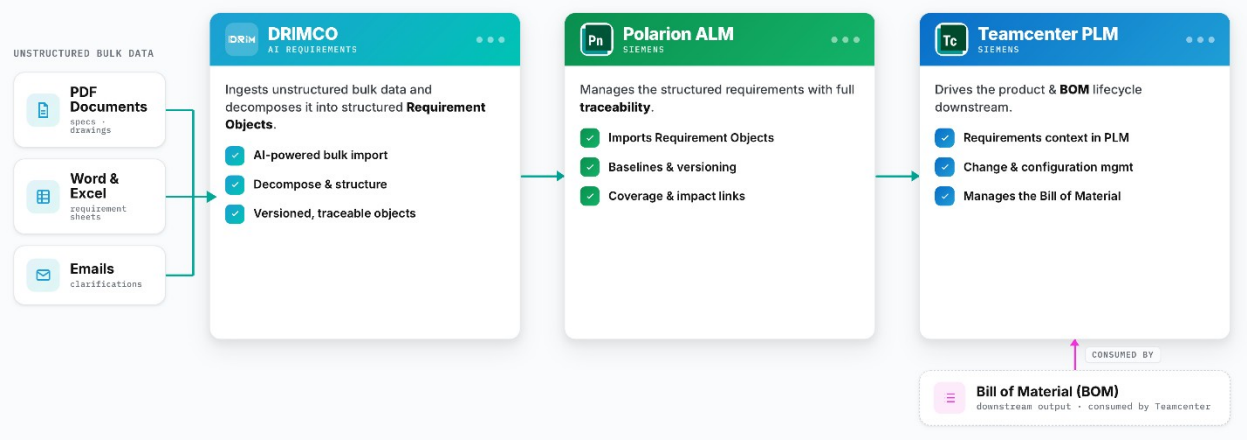

Figure 4. *The three pillars – DRIM AI, Polarion ALM & Teamcenter PLM*

Data class	Authoritative owner	Role of the other systems
Commercial opportunity	CRM	Proxied into Polarion as an Opportunity work item; synced daily
Customer package files	Teamcenter PLM	Streamed to DRIM for processing; never duplicated as a master
Requirement objects & workflow	Polarion ALM	Published downstream to PLM; elicited upstream by DRIM
Requirement elicitation & revisions	DRIM AI	Pushes validated objects to Polarion; not a system of record
Awarded-project identity	Project Management Software master data	Drives project creation in PLM and ALM on award

Table 2. The systems-of-record matrix — one authoritative owner per data class.

4.3 The end-to-end lifecycle flow

Assembled, the pieces describe a single governed pipeline from opportunity to award:

1. **Originate.** A commercial opportunity in the CRM is proxied into Polarion as an Opportunity work item, which carries the opportunity's attributes and mirrors its status.
2. **Provision.** Creation of the Polarion opportunity work item triggers automatic creation of a corresponding DRIM opportunity workspace, so the AI environment is ready before any document arrives.
3. **Ingest.** Customer files held in Teamcenter are streamed to DRIM as data in motion (no intermediate storage) under the Orchestrator Bus, governed by load-balancing parameters.
4. **Understand & elicit.** DRIM normalizes, detects layout, and proposes requirement candidates; engineers validate, merge, split, and annotate, assigning criticality, topic, and compliance status.

5. **Record.** Validated requirements publish to Polarion as work items inside Live Documents, where compliance assessment, precedence resolution, and cost-adder collaboration take place against a full audit trail.
6. **Publish.** Polarion publishes the requirement structure to Teamcenter, associating each object with its opportunity or project container by published attribute.
7. **Dispose & carry forward.** On award, the opportunity is finalized and — via project master-data synchronization — linked to one or more execution projects; relevant documents branch from the opportunity workspace into the execution workspace(s), preserving lineage. A lost opportunity is finalized with its content intact for reuse.

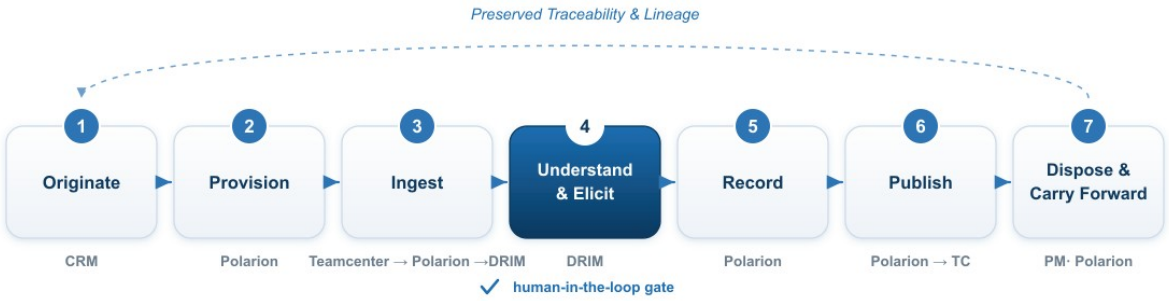

Figure 5. *The seven-stage bid-to-award flow, with the owning system beneath each stage, a human-in-the-loop gate at elicitation, and preserved traceability.*

4.4 Synchronization mechanics

Because the three systems run independently rather than as one combined platform, keeping their information aligned is treated as a deliberate part of the design, not something that happens on its own. When the systems are first set up, each piece of information is mapped to its matching home in the other systems, so that data created in one place reliably arrives where it belongs in the next. Updates flow in both directions, and the design allows for the fact that a change made in one system takes a short time to appear in another. A routine check runs on a schedule to compare the systems and confirm they still agree, catching any mismatch early — before a piece of information ends up with no proper home in the system it was meant to reach. The goal is not flawless, instant agreement between systems, which independent systems can never fully guarantee, but agreement that is dependable, visible, and able to correct itself.

> **KEY TAKEAWAY**
> *The architecture's power comes from restraint: each system does only what it is authoritative for, the AI layer is bounded to elicitation, and the connective logic lives in one orchestration layer rather than being smeared across point-to-point integrations.*

5. Implementation Strategy

The capability of this scope is adopted incrementally, not in a single cutover. The recommended approach is staged by lifecycle phase and phased-by-environment within each phase, so that scope and risk are contained at every step.

5.1 Staged rollout by lifecycle phase

Sequencing delivery by lifecycle phase lets the organization realize value early while deferring the most uncertain integrations:

- **Phase 1 — Order-to-Cash (execution).** Establishes the ALM–PLM backbone, the requirement work-item model, document workflow, and the published Polarion-to-Teamcenter integration on awarded projects.
- **Phase 2 — Opportunity-to-Quote (bid/tender).** Adds the opportunity work item, DRIM opportunity workspaces, AI elicitation, the Orchestrator Bus and file-transfer module, compliance and precedence handling, and the opportunity-to-project linkage that prevents Engineering Regret.
- **Subsequent phases.** Extend automation (for example, deeper CRM-to-ALM connector behavior and broadened publish-back to PLM) once the core is stable and access dependencies are resolved.

5.2 Phased-by-environment execution

Within a phase, deployment proceeds one business unit and one environment at a time. A representative cadence develops first in a single lead environment, validates in that unit's QA environment through formal user-acceptance testing, and only then rolls out to the remaining development and QA environments. This contains blast radius and lets configuration patterns be proven before they are propagated.

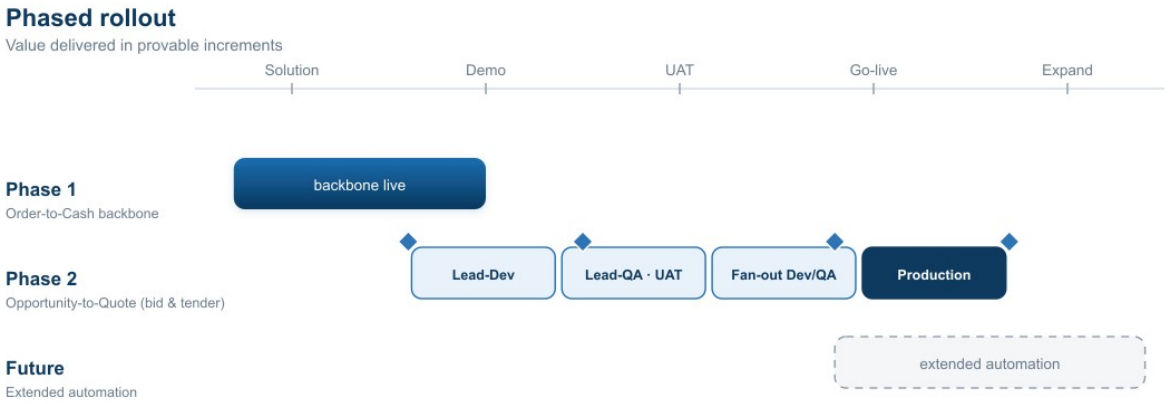

Figure 6. *Phased rollout: Wave 1 backbone live, Wave 2 advancing through environment gates to production, and future automation to follow.*

5.3 Technical execution discipline

Each step toward going live follows the same disciplined sequence that separates a safe, controlled rollout from a risky one:

1. **Set up the system. Configure the building blocks each team will use (the kinds of records they track, the information fields, how items connect to one another, the approval steps, and the reports) and map each piece of information to its matching home in the other systems so that nothing ends up with no proper place to land**.
2. **Dry runs.** Run the full process end to end on a representative sample of real customer documents to uncover unusual document types and reading errors before any users are involved.
3. **Run old and new side by side. Process the same documents through both the new system and the existing process at the same time, then compare the results to build confidence and measure the difference**.
4. **Fix problems found along the way. Resolve the technical glitches that surface during setup (for example, where the systems hand information off to one another) and build in checks at each stage so that any failure is caught and easy to trace rather than passing unnoticed.**
5. **Confirmation by the people who will use it. Have the responsible team check the system against real business situations and sign off before it goes live**.
6. **Careful go-live and ongoing checks. Switch the system on for everyday use and turn on the routine check that keeps confirming the systems still agree after the switch**.

5.4 Governance and risk controls

Two governance practices materially de-risk the program. First, a clear responsibility model — accountable business-unit owners, responsible delivery and integration partners, and named consults — keeps decisions and escalations unambiguous across the multi-party effort. Second, the program should be explicit about deferring scope it cannot yet safely deliver: integrations that depend on external access (for instance, a CRM connector pending development credentials) are formally parked rather than half-built, and manual fallbacks are defined wherever an attribute cannot yet be mapped automatically. A configurable platform that supports tailoring — suppressing unneeded fields and views per phase — lets a single template serve both the bid and execution phases without forking.

> **KEY TAKEAWAY**
> *Treat the rollout as a sequence of provable increments. Every promotion should be earned by a dry run, a parallel comparison, and a UAT sign-off, never assumed.*

6. Business Value & ROI

The value of the architecture is best understood as the removal of specific, recurring costs from the bid lifecycle. The levers below are presented qualitatively, with the few quantitative anchors

that the operating characteristics of the systems support; organizations should calibrate them against their own baselines rather than treat any single figure as a promise.

6.1 Reduced overhead

The largest cost removed is manual requirement shredding. By automating document understanding and proposing structured requirement candidates, the AI layer compresses the most labor-intensive step in the bid into a validation exercise. Reuse compounds the saving: a per-business-unit standard-comments library and the ability to copy cost adders, requirements, and clarifications from a matching document in another opportunity mean the organization stops paying repeatedly for the same engineering judgment. Eliminating manual cross-system re-keying — by harmonizing fields and synchronizing automatically — removes a further class of low-value, error-prone effort.

6.2 Faster time-to-market on bids

Quote turnaround is a competitive variable. Automated pre-processing, a single opportunity workspace, an observable publishing queue, and live completeness dashboards collapse the elapsed time between receiving a tender and producing a substantiated response. Faster, more accurate bids let the organization pursue more opportunities at constant engineering capacity, and improve the odds on each: the same team can credibly cover a wider funnel.

6.3 Enhanced compliance and reduced risk

Compliance shifts from a manual, after-the-fact check to a property of the system. A controlled standards library with revision and deviation tracking flags out-of-date references automatically; enforced order-of-precedence resolves source conflicts consistently and records the rationale; missing-document detection prevents incomplete packages from advancing unnoticed; and a complete who/when/what audit trail makes commitments defensible. For organizations exposed to contractual and regulatory scrutiny, this is risk reduction with a direct financial dimension.

6.4 Continuity — the end of Engineering Regret

Because validated requirements, comments, and assessments branch forward from the opportunity workspace into execution projects with their lineage intact, engineering effort performed during bidding need not be thrown away. Family-identity and refines/refined-by linkage preserve the audit trail across revisions. The cumulative effect is that the organization stops re-doing work it has already done, the most insidious and least-measured cost in the current state.

6.5 Scalability as a first-class outcome

Finally, the architecture is built for the volumes the domain actually produces — master-data feeds of tens of thousands of records, large multi-file customer packages, and many concurrent opportunities across business units — by streaming files as data in motion and load-balancing transfer explicitly. Capacity ceases to be the binding constraint on how many opportunities the organization can credibly pursue; engineering judgment, not document handling, becomes the limit.

Value lever	Mechanism in the architecture	Primary beneficiary
Lower bid-prep labor	AI elicitation + reuse libraries replace manual shredding	Engineering, bid team
Faster quote turnaround	Single workspace, publishing queue, live dashboards	Sales, estimation
Stronger compliance	Standards library, precedence enforcement, audit trail	Quality, legal, leadership
No lost engineering	Branching + lineage from opportunity to project	Engineering, delivery
Scale without headcount	Data-in-motion transfer, load balancing, automation	IT, operations

Table 3. Value levers mapped to the architectural mechanisms that produce them.

> **KEY TAKEAWAY**
> *The return is not a single line item. It is the conversion of the bid lifecycle from a manual cost center, with leaking engineering value, into a governed, scalable, and reusable asset.*

7. Conclusion

The bid-and-tender phase has long been the blind spot of engineering digitization: a high-stakes, document-heavy process left to manual effort even as the rest of the lifecycle was instrumented. The architecture set out in this document closes that gap without overreaching. It does not ask the organization to trust AI as an unsupervised author; it asks it to let AI remove the document-handling tax so that engineers can spend their time on engineering. It does not replace proven systems; it gives each one a clear mandate and binds them through a single orchestration layer.

The operational advantage is concrete and compounding. Tenders are assessed faster and priced more accurately. Compliance becomes a property of the system rather than a manual afterthought. Engineering judgement is captured as reusable, traceable data and carried intact from opportunity to award, ending the quiet waste of Engineering Regret. And the whole pipeline is built for the volumes the energy and process industries actually generate. Delivered in disciplined, provable phases, this architecture turns the front end of the funnel — where margin is decided — from a bottleneck into a durable competitive capability, and lays the foundation for the next step: AI that not only elicits requirements, but begins to predict the links between them.

> **KEY TAKEAWAY**
> *Win more, by bidding faster, more compliantly, and without ever losing the engineering you have already done.*