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# Establishing an Optimised Interface Protocol Between Macro and Micro Planning Systems in Infrastructure Projects: A Proposed Framework for Control and Performance Management

**Ming Xu**
Director
X&L Engineering Pty Ltd
Honorary Senior Fellow
University of Melbourne, Melbourne, Australia
ming.xu@xleng.com.au

**Bing Li**
Director
X&L Engineering Pty Ltd
bing.li@xleng.com.au

**Felix Kin Peng Hui**
Associate Professor
Department of Infrastructure Engineering
University of Melbourne, Melbourne, Australia
kin.hui@unimelb.edu.au

## Abstract

Effective planning remains the cornerstone of any successful infrastructure project delivery. Large construction projects typically operate across two interconnected levels of planning: a macro-level master program, often built in Primavera P6, and a micro-level short-term plan, developed in tools such as Aphex or Microsoft Project. Despite their shared purpose, these systems are frequently disconnected. This results in misaligned data, inconsistent reporting, and reduced confidence in the overall project schedule. This paper proposes an optimised Macro–Micro Planning Interface Protocol (MM-PIP) that establishes a logical and data-driven bridge between the two planning levels. The framework defines consistent Levels of Detail (LoD), aligns Work Breakdown Structures (WBS) with Cost Breakdown Structures (CBS), and sets clear governance rules for progress integration and performance measurement. Drawing from ISO 21511, PMBOK (7th Edition), AACE Recommended Practices, and practical experience on major Australian infrastructure projects, this study demonstrates that a systematically defined interface significantly improves reporting clarity, schedule reliability, the overall project control and performance management.

## Keywords
Primavera P6, construction planning, project controls, macro - micro interface, performance measurement

## 1. Introduction

The planning and control of large infrastructure projects are inherently complex, requiring the coordination of multiple disciplines, contractors, and interfaces over extended timeframes. In practice, construction programs operate on two interconnected levels of planning:

- a macro-level program, usually developed in software platform typically Primavera P6, which governs strategic sequencing, baseline management, and contract reporting; and
- a micro-level program, built in tools such as Aphex or Microsoft Project, which focuses on daily and weekly work coordination, access planning, and resource deployment on site.

While these two systems serve distinct but complementary purposes, they are often developed and maintained in isolation. The absence of an optimised protocol defining how data should flow between them creates misalignment in activity logic, duplicate data entry, and inconsistent performance measurement. This disconnect undermines the reliability of project reporting and weakens overall project control (Olawale & Sun, 2015; Hwang & Ng, 2013).
A consistent and well-governed interface between macro and micro systems ensures that daily construction data supports project-level control. This interface must clearly define:

- the Level of Detail (LoD) expected at each planning stage;
- the boundaries between tools (macro vs. micro); and
- the mechanisms by which data - such as progress, constraints, or changes - feeds upward into the master program.

Establishing such a framework also strengthens the relationship between the Work Breakdown Structure (WBS) and Cost Breakdown Structure (CBS), creating traceable connections between scope, schedule, cost and responsibility. These linkages form the backbone of reliable Earned Value Management (EVM) and performance reporting (PMI, 2021; AACE, 2011; CIOB, 2021). This in turn will impact decision making.

This paper proposes an optimised approach to managing this interface: the Macro–Micro Planning Interface Protocol (MM-PIP). The MM-PIP defines the hierarchy, information flow, and control logic required to integrate Primavera P6 and Aphex within a consistent project governance framework. The paper draws from established project management standards - PMBOK (7th Edition), ISO 21511, and AACE RP 37R-06 based on the author's practical experience of major transport infrastructure projects recently delivered in Australia.

The proposed MM-PIP framework establishes a single, coherent planning ecosystem that supports better decision-making, reduces administrative duplication, and enhances confidence in program data across all levels of project delivery.

## 2. Literature Review

The delivery of complex infrastructure projects requires a hierarchical planning structure that ensures consistency between long-term strategic objectives and day-to-day execution (Winch, 2010; Kerzner, 2017). According to the Project Management Institute (PMI, 2021), this hierarchy enables the alignment of scope, schedule, and cost, forming the foundation for integrated project control. Similarly, the Association for the Advancement of Cost Engineering (AACE) emphasises that planning must progress through defined levels of detail, with each level serving a specific control function (AACE, 2011).

The ISO 21511:2018 standard reinforces this view by prescribing a multi-level Work Breakdown Structure (WBS) that decomposes project scope into manageable units. Each level of the hierarchy must maintain traceability to its parent elements, allowing data aggregation and roll-up for reporting and governance. This structured decomposition supports transparency and decision-making by enabling managers to track how performance at the operational level affects the overall project outcome.

However, despite the availability of these standards, the industry still struggles to maintain a consistent hierarchy within planning systems. Research by Olawale and Sun (2015) revealed that over 70% of construction organisations experience schedule misalignment between different planning tools. Likewise, Flyvbjerg (2023) and Love et al. (2016) note that mismanagement of program detail contributes to schedule instability and misreporting, which in turn lead to poor decision-making at executive levels.

The concept of hierarchical planning also aligns with Lean Construction principles, particularly the "Last Planner System," which emphasises commitment-based short-term planning linked to long-term objectives (Ballard & Tommelein, 2021). The MM-PIP framework proposed in this paper complements this principle by providing a structured interface that links macro plans (commitment horizon) with micro plans (execution horizon).

## 2.1 The Work Breakdown Structure (WBS)

The WBS is the backbone of project planning and control. It defines the scope of work in a structured hierarchy, ensuring that all project deliverables are captured and traceable (PMI, 2021). The Chartered Institute of Building (CIOB, 2021) describes the WBS as the single organising framework through which time, cost, and resource data can be integrated. The AACE RP 37R-06 recommends a consistent six-level WBS for large-scale engineering and construction projects, which ensures that data can be aggregated across work packages while retaining sufficient detail for control and reporting.

A well-structured WBS provides the foundation for both macro planning (project-level control) and micro planning (task-level coordination). In practice, these levels are represented as below in Table 1:

Table 1. Example WBS Hierarchy for Infrastructure Projects

| WBS Level | Description | Example |
|---|---|---|
| Level 1 | Project | The Overall Project |
| Level 2 | Phase | Design, Procurement, Construction |
| Level 3 | Zone / Section | Zone A – Northbound Corridor |
| Level 4 | Discipline / Element | Bridge Works, Pavement, Utilities |
| Level 5 | Sub-Element | Abutments, Retaining Walls |
| Level 6 | Activity | Reinforcement, Formwork, Concrete Pour |

In Primavera P6, this structure typically forms the foundation for the baseline program. It enables aggregation of activities into control accounts, which can be linked to CBS codes and resources for reporting. When the WBS is inconsistent or fragmented, project teams lose the ability to trace cost and time performance back to defined scope, leading to disputes and inefficiencies (Flanagan et al., 2014).

## 2.2 Macro and Micro Planning Systems

Construction planning tools have evolved to support distinct but complementary purposes. Primavera P6 is designed for enterprise-level project control, critical path analysis, and earned value measurement (Oracle, 2023). It provides the master schedule and acts as the contractual reference for time management and progress reporting. Conversely, Aphex and Microsoft Project operate at the operational front line, providing platforms for site teams to coordinate daily and weekly activities, manage constraints, and track real-time performance (Aphex, 2024).

While P6 operates with a planning time scale of months or years, micro-level tools such as Aphex focus on short-term, typically days or hours (for occupation works). The granularity of data in these tools allows planners and supervisors to adapt rapidly to changing conditions on site (Park et al., 2017). However, without a defined interface between the two, the flow of information can become fragmented. Table 2 summarises the differing functions and control horizons of these systems.

Table 2. Comparison of Macro and Micro Planning Tools

| Attribute | Macro (Primavera P6) | Micro (Aphex / MS Project) |
|---|---|---|
| Primary Purpose | Strategic control, forecasting, reporting | Execution planning and coordination |
| Time Horizon | 3 months – 5 years | 1 day – 6 weeks |
| Level of Detail | WBS 1–6 | Task / Crew / Shift level |
| Users | Project Controls, Management | Site Engineers, Supervisors |
| Update Frequency | Monthly / Yearly | Daily / Hourly |
| Reporting Output | KPI dashboards, EVM, milestones | Lookahead schedules, readiness reports |

Empirical evidence from McKinsey (2017) and Love et al. (2016) indicates that projects without defined planning interfaces suffer from productivity losses exceeding 20% due to duplicated or inconsistent scheduling efforts. The integration of macro and micro planning through a defined interface mitigates this risk by clarifying ownership of data and ensuring alignment between execution and control.

### 2.3 The Cost Breakdown Structure (CBS)

The Cost Breakdown Structure (CBS) complements the WBS by organising financial data in alignment with work scope. According to the AACE (2011) and CIOB (2021), integration between WBS and CBS is critical for performance measurement because it enables cost and schedule data to be compared at consistent levels of detail. The PMBOK Guide (2021) identifies this integration as the cornerstone of effective Earned Value Management (EVM), allowing calculation of Schedule and Cost Performance Indices (SPI and CPI).

When WBS and CBS are misaligned, time and cost data become incomparable, resulting in unreliable forecasts and weak financial control (Hendrickson, 2008; Love & Irani, 2016). Therefore, maintaining consistent LoD across WBS and CBS is essential for accurate performance reporting and auditability.

### 2.4 Industry Practices and the Interface Challenge

Despite advancements in digital project management, the construction sector continues to face challenges in integrating its planning systems. Studies by Navon (2007) and Dawood & Sikka (2008) found that over half of construction projects still rely on manual updates between short-term plans and master schedules. This creates lagging information flow, distorted reporting cycles, and confusion over the "single source of truth."

Similarly, Turkan et al. (2012) demonstrated that automated progress tracking through digital models (4D BIM) significantly improves accuracy—but only when schedule data is structured and linked consistently. The ISO 19650 standard (2018) also reinforces the importance of a common data environment (CDE) to ensure consistency between modelling, scheduling, and reporting systems.

The MM-PIP proposed in this paper builds upon these foundations by providing a clear, structured mechanism for defining the boundary between macro and micro systems. It integrates the hierarchical logic of ISO 21511 with the practical, field-based planning principles of lean construction and rolling-wave scheduling (Alarcón et al., 2005).

## 3. Methodology and Framework Development

The development of the Macro–Micro Planning Interface Protocol (MM-PIP) was guided by a combination of established project management standards and observed industry practice across large-scale infrastructure projects in Australia. The methodology follows a mixed-structure approach:

- Standards-based design – Drawing from the PMBOK Guide (2021), AACE RP 37R-06, ISO 21511, and CIOB Scheduling Code of Practice (2021), which collectively define best practice for project breakdown, scheduling, and control.
- Practical alignment – Incorporating project control lessons from major infrastructure projects where Primavera P6 and Aphex were concurrently applied.
- Analytical synthesis – Combining theoretical hierarchy and observed workflow patterns into a single structured interface model, defining both data and process integration.

The aim was to establish a replicable structure that maintains the contractual integrity of macro-level schedules while ensuring the operational agility of micro-level planning. This balance enables projects to function efficiently at both strategic and tactical levels, reducing administrative rework and improving reporting consistency (Love et al., 2016; Wamelink & Heintz, 2015).

### 3.1 Framework Objectives

The MM-PIP framework was designed to address five core objectives:

- Eliminate schedule fragmentation by defining clear roles, responsibilities, and data flows between macro and micro systems.
- Ensure consistency of detail by standardising the level of information presented in each system (LoD).
- Align WBS and CBS structures for transparent performance measurement.
- Enhance control governance by assigning accountability to specific teams and review cycles.

- Improve progress traceability through defined feedback mechanisms from site to project controls.

This integrated approach directly supports the Earned Value Management (EVM) principle that performance data must be derived from a single, verified source aligned to the project's control baseline (PMI, 2021; AACE, 2011).

### 3.2 Framework Design and Architecture
The MM-PIP framework is structured around three interacting dimensions:

- Information Hierarchy (Structure): The logical relationship between macro and micro levels defined through the WBS and LoD matrix.
- Governance Process (Flow): The sequence of planning, validation, and reporting cycles linking field data to program control.
- Technology Integration (Systems): The digital connection between Primavera P6, Aphex, and the Common Data Environment (CDE).

At the core of this architecture is the principle of "controlled interoperability." Each tool performs within its defined LoD boundary while maintaining traceability through common WBS codes. The framework does not replace or merge tools but creates a structured handshake between them, governed by consistent rules for data ownership, update cycles, and change management (Park et al., 2017; Oracle, 2023).

### 3.3 Work Breakdown Structure (WBS) Alignment Logic
A consistent WBS is the foundation of the MM-PIP. It establishes the vertical link between the macro and micro systems and ensures that all planning data—time, cost, and performance—is logically related.
In the macro schedule, Primavera P6 manages Levels 1 to 6 as follows:

- Level 1: Project – Defines overall scope and contractual boundary.
- Level 2: Phases – Design, Procurement, Construction, Testing, and Commissioning.
- Level 3: Zones or Stages – Logical or geographical subdivisions (e.g., tunnel sections, road corridors).
- Level 4: Disciplines or Elements – Structural, civil, mechanical, electrical.
- Level 5: Sub-elements – Specific work packages (e.g., bridge abutments, retaining walls).
- Level 6: Activities – Executable tasks forming the lowest level of macro control.

The micro-level planning environment manages sub-activities below Level 6, where details such as crew assignments, shift sequencing, and short-term constraints are tracked (Aphex, 2024). This hierarchical alignment prevents overlap between tools and ensures that progress updates from Aphex can be accurately summarised into P6 without loss of data fidelity.

### 3.4 Cost Breakdown Structure (CBS) Integration
Aligning the WBS with the CBS allows schedule performance to be directly correlated with financial expenditure. Each WBS code corresponds to a CBS code that captures associated cost elements—labour, plant, materials, and subcontractor inputs (AACE, 2011).
This alignment supports:

- Integrated Performance Measurement: Linking cost, schedule, and scope for Earned Value analysis (Flanagan et al., 2014).
- Variance Analysis: Identifying schedule and cost deviations early, supporting proactive control (Love & Irani, 2016).
- Forecasting Accuracy: Enabling predictive performance reporting based on real-time field data (Hendrickson, 2008).

When the WBS and CBS structures are inconsistent, projects lose visibility into cost performance at the work-package level, causing unreliable EVM metrics and weakened audit traceability. A consistent LoD across both structures forms the cornerstone of effective program control and financial governance.

### 3.5 Level of Detail (LoD) Matrix
The MM-PIP framework requires a Level of Detail Matrix, which defines the appropriate granularity for each planning level. This prevents both excessive complexity and insufficient definition in schedules (Table 3).

Table 3. Level of Detail Matrix

| Planning Level | Description | Tool | Typical LoD Content |
|---|---|---|---|
| Level 1 | Project | P6 | Major milestones and deliverables |
| Level 2 | Phase | P6 | Design, procurement, construction phases |
| Level 3 | Zone / Stage | P6 | Geographic or staging boundaries |
| Level 4 | Discipline / Element | P6 | Structural or system-level sequences |
| Level 5 | Sub-Element | P6 | Work packages, measurable scope items |
| Level 6 | Activity | P6 / Aphex | Task-level logic, start/finish controls |
| Level 7+ | Sub-Activity / Crew | Aphex | Crew-level detail, shift plans, constraints |

The LoD matrix forms a governance boundary between P6 and Aphex. Any planning activity exceeding Level 6 is executed and controlled in Aphex, while P6 maintains summarised representations of those activities. This approach ensures reporting consistency without overloading the master schedule (CIOB, 2021; AACE, 2011).

### 3.6 Data Flow and Integration Rules

Information within the MM-PIP flows through a structured process comprising three core cycles:

- Planning Cycle: P6 defines baseline logic, which is decomposed into execution packages in Aphex.
- Execution Cycle: Site teams update daily progress, constraints, and resource data in Aphex.
- Reporting Cycle: Validated progress data is summarised weekly and synchronised back into P6 for performance reporting.

This cyclical integration ensures that information from site activities continuously informs the master program while maintaining P6 as the single source of truth for contractual reporting.

By standardising the timing, ownership, and structure of updates, the MM-PIP reduces the risk of conflicting data and provides reliable inputs for cost, schedule, and performance analysis (Navon, 2007; Dawood & Sikka, 2008).

### 3.7 Governance and Control Framework

A robust governance framework is central to maintaining data integrity across systems. The MM-PIP defines roles and responsibilities at each stage of the planning and reporting process in Table 4 below.

Table 4. Stage based Roles and Responsibilities

| Role | Responsibility |
|---|---|
| Project Controls | Maintain P6 baseline, manage critical path, integrate progress data |
| Planners / Engineers | Develop and update micro plans in Aphex |
| Site Supervisors | Record progress, constraints, and short-term changes |
| Project Manager | Approve key updates, validate program impacts |
| Cost Control Team | Align CBS data, validate cost performance |
| Quality / Assurance | Audit compliance with LoD and WBS structure |

Governance protocols require scheduled review cycles - daily in Aphex, weekly at planning coordination meetings, and monthly at executive reporting reviews. This structure maintains consistent communication and ensures that information remains current, validated, and aligned to the project baseline.

## 4. The Interface Protocol

The Macro–Micro Planning Interface Protocol (MM-PIP) serves as a structured mechanism for managing the exchange of information between Primavera P6 and Aphex. Its purpose is not to merge the two systems, but to establish a disciplined handshake—a controlled, traceable method by which data moves between project control (macro) and daily execution (micro).

This protocol is underpinned by three guiding principles:

- Clarity of purpose: Each planning tool operates within a defined control boundary and serves a unique function.
- Consistency of structure: Both systems share the same WBS and LoD framework to ensure seamless alignment.

- Governed data flow: Updates are synchronised through formal processes and roles, maintaining the integrity of the master schedule.

When implemented correctly, this interface prevents duplication, ensures consistent data interpretation, and allows teams to focus on execution rather than administrative reconciliation (CIOB, 2021; Park et al., 2017).

## 4.1 Control Boundaries Between Systems

The MM-PIP establishes clear boundaries that define what each system is responsible for, preventing overlap and loss of control (Table 5).

Table 5. Control Boundaries Between P6 and Aphex

| **Function** | **Primavera P6 (Macro)** | **Aphex (Micro)** |
|---|---|---|
| Baseline Schedule | Maintains official contractual program | Not applicable |
| Activity Logic and Critical Path | Managed by Project Controls | Mirrored for context only |
| Work Package Detail | Defined by WBS Level 5–6 | Expanded into daily tasks |
| Daily Constraints and Readiness | Not tracked | Fully managed by site team |
| Resource Allocation | Strategic level | Crew and shift level |
| Reporting and KPI | Project and phase dashboards | Lookahead and operational reports |

This division ensures that Primavera P6 remains the authoritative system for contract management, delay analysis, and earned value reporting, while Aphex provides the agility and precision needed for operational control.

## 4.2 Integration Workflow

The data flow between P6 and Aphex follows a cyclical process comprising five main stages:

- Scope Release: Activities at WBS Level 6 are exported or manually released from P6 to Aphex. Each carries a unique WBS identifier and planned duration.
- Short-Term Decomposition: Within Aphex, site teams break these work packages into detailed short-term tasks, applying constraints such as access, permits, or dependencies.
- Progress Capture: As work progresses, site teams update completion percentages, planned vs. actual start/finish dates, and key observations.
- Data Validation: The planning or project controls team reviews updates weekly, ensuring they align with project sequencing and logic.
- Feedback and Synchronisation: Aggregated progress data is imported back into P6, updating the master program for reporting and performance analysis.

This cyclical integration model maintains P6 as the single source of truth while enabling the micro system to serve as the "engine room" for daily performance feedback (Navon, 2007; Dawood & Sikka, 2008).

## 4.3 Integration Gateways and Control Points

To maintain schedule integrity, data exchange between systems passes through specific Integration Control Points (ICPs). These checkpoints ensure that updates are validated before being reflected in the master schedule (Table 6).

Table 6. Integration Control Points

| **Gateway** | **Purpose** | **Owner** | **Frequency** |
|---|---|---|---|
| ICP-1 | Activity release and coding verification | Project Controls | Project mobilisation or baseline approval |
| ICP-2 | Micro schedule validation and alignment | Planner | Weekly |
| ICP-3 | Progress verification and variance review | Construction Manager | Weekly |
| ICP-4 | Data upload and master schedule update | Project Controls | Monthly |
| ICP-5 | Executive reporting and performance review | Project Manager / Director | Monthly |

The establishment of these gateways provides accountability and auditability at every stage of the data flow. This approach aligns with the governance principles outlined in ISO 19650 (2018) and AACE RP 29R-03 (2017), which emphasise data validation before integration into controlled systems.

## 4.4 Change Management and Version Control

Schedule changes must be handled through a disciplined change-control process. Under the MM-PIP framework:

- Only Project Controls can modify baseline logic or critical paths in P6.
- Site-level changes in Aphex (e.g., resequencing due to weather or access) are recorded as deviations and submitted for review.
- Approved changes are either reflected as temporary workarounds or formal baseline revisions, depending on their material impact.

Each revision is logged in a Schedule Change Register maintained in the Common Data Environment (CDE). This ensures that all stakeholders operate from a consistent dataset and that historical versions remain traceable (CII, 2012; Oracle, 2023).

## 4.5 Reporting and Performance Measurement

Integrating P6 and Aphex through the MM-PIP enables unified performance reporting across both macro and micro horizons.

Performance indicators include:

- Schedule Performance Index (SPI) and Cost Performance Index (CPI) – calculated from the WBS - CBS aligned data (AACE, 2011).
- Lookahead Compliance Rate – measuring adherence of site execution to planned short-term targets (Aphex, 2024).
- Variance Analysis – identifying deviations between planned and actual durations at both macro and micro levels.

Reports are structured around the WBS hierarchy, allowing each project phase or zone to be analysed consistently across levels. This unified reporting structure significantly improves decision-making and transparency (Flanagan et al., 2014; Love et al., 2016).

## 4.6 Interface Rules of Engagement

To maintain consistency and avoid conflict between planning levels, the MM-PIP enforces the following rules of engagement:

- Primavera P6 retains baseline and critical-path ownership.
- Aphex manages short-term, resource-constrained planning and daily progress tracking.
- Every task in Aphex must map directly to a WBS code (or Activity ID) in P6.
- Progress reported in Aphex must be validated through weekly reviews before integration.
- Updates must follow fixed time cycles - daily updates in Aphex, fortnightly roll-ups into P6.
- No new activities are to be added in P6 without corresponding WBS alignment and approval.

These principles establish discipline in program management while maintaining flexibility in day-to-day operations. They also align with governance practices advocated by the CIOB Code of Practice (2021) and AACE RP 37R-06, which recommend maintaining consistency between baseline and execution-level planning tools.

### 4.7 Data Governance and Common Data Environment (CDE)

A Common Data Environment (CDE) serves as the backbone for storing, validating, and sharing planning data. The CDE houses the baseline schedule, micro-level progress exports, and change-control records, ensuring that all stakeholders access verified and version-controlled data.
Governance within the CDE follows three principles:

- Transparency: All updates and approvals are recorded and accessible.
- Traceability: Each data modification is tagged to a responsible individual and date.
- Integrity: The CDE is the sole platform for official data exchange between P6 and Aphex.

The integration of the CDE into planning governance not only enhances compliance with ISO 19650 requirements but also reduces administrative workload by automating validation and storage processes (Wamelink & Heintz, 2015; Eastman et al., 2018).

### 4.8 Interface Benefits and Outcomes

When properly implemented, the MM-PIP delivers measurable benefits across all control dimensions:

- Enhanced Consistency: Standardised LoD and data structures eliminate duplication and ambiguity.
- Improved Forecasting: Consistent progress inputs support reliable performance projections.
- Reduced Administrative Effort: Automated data exchange minimises manual reconciliation.
- Greater Accountability: Clearly defined ownership of data at each planning level.
- Increased Transparency: Unified reporting creates shared understanding among stakeholders.

Ultimately, the MM-PIP strengthens project governance and supports informed decision-making by creating a coherent, integrated planning environment across all management levels.

## 5. Discussion and Industry Implications

The implementation of the Macro–Micro Planning Interface Protocol (MM-PIP) reinforces a fundamental principle in modern project management: that structured governance, rather than technology alone, determines the success of digital integration. The case study demonstrates that without an agreed interface, even the most advanced scheduling tools can produce inconsistent or unreliable outcomes (Hwang & Ng, 2013; Love & Irani, 2016). Conversely, when the interface between systems is governed through defined protocols, projects achieve consistency, traceability, and control at all levels.

This section discusses the broader implications of the MM-PIP for industry practice, focusing on governance, integration, digital transformation, and long-term scalability.

### 5.1 Governance and Control Benefits

Effective governance is at the heart of successful program control. By defining clear responsibilities, data boundaries, and validation processes, the MM-PIP aligns with internationally recognised governance principles (PMI, 2021; AACE, 2011).

The protocol reinforces the concept that Primavera P6 must remain the "single source of truth" for baseline control and performance reporting, while tools like Aphex serve as operational extensions of that baseline. This arrangement creates a closed-loop governance system, ensuring that all performance data collected in the field can be traced back to its WBS origin and corresponding CBS cost account.

Such governance not only supports more accurate Earned Value Management (EVM) but also strengthens contractual defensibility, as all reported progress is validated through a controlled data flow. This has significant implications for managing delay claims, progress certifications, and commercial reporting under contracts such as NEC4, AS4000, and FIDIC (NEC, 2017; Standards Australia, 1997; FIDIC, 2017).

### 5.2 Digital Integration and Information Management

Digital integration in construction has matured rapidly in the past decade, with Building Information Modelling (BIM) and CDEs becoming standard practice for design and documentation (ISO 19650, 2018). However, planning and scheduling often lag behind these advancements due to fragmented data ownership and inconsistent standards (Eastman et al., 2018; Wamelink & Heintz, 2015).

The MM-PIP bridges this gap by establishing data interoperability between planning systems. The framework's alignment with ISO 19650 ensures that scheduling information becomes part of the structured digital asset record, not a separate or disconnected dataset. This supports 4D BIM integration, where schedule data drives model sequencing and digital rehearsals (Turkan et al., 2012; CIOB, 2021).

As more clients demand integrated digital delivery, this protocol provides a practical model for unifying time, cost, and information management. It lays the foundation for Digital Twins, where live schedule informs predictive analytics and performance forecasting (IPA, 2021; Alarcón et al., 2005).

### 5.3 Lean Planning and Continuous Improvement

From a lean construction perspective, the MM-PIP introduces a structured way to connect commitment-based planning (macro) with execution-based planning (micro). The alignment between Primavera P6 and Aphex supports Last Planner System principles by providing reliable lookahead visibility, constraint analysis, and workflow predictability (Ballard & Tommelein, 2021; Alarcón et al., 2005).

The feedback loop built into the MM-PIP transforms progress reporting from a retrospective exercise into a continuous improvement process. By capturing actual production rates, resource utilisation, and delay causes at the micro level, planners can recalibrate future forecasts at the macro level. This promotes a culture of learning, accountability, and data-driven decision-making.
Over time, this iterative loop enhances organisational maturity in planning and control, shifting the role of planners from reactive schedulers to proactive performance managers.

### 5.4 WBS - CBS Alignment and Performance Measurement

Aligning the Work Breakdown Structure (WBS) with the Cost Breakdown Structure (CBS) is essential for achieving integrated project control. When both are synchronised under a consistent LoD, cost and schedule variances can be measured within the same analytical framework (AACE, 2011; Flanagan et al., 2014).

The MM-PIP ensures that this alignment is maintained by embedding CBS codes directly into WBS elements in Primavera P6 and cascading them into Aphex tasks. This creates traceable cost-to-schedule relationships that underpin Earned Value Analysis (EVA) and Performance Measurement Baseline (PMB) management (Hendrickson, 2008; PMI, 2021).

This unified approach also allows for more granular reporting of productivity and efficiency metrics, enabling early identification of underperforming work packages. It forms the basis for data-driven benchmarking and portfolio-level analytics, improving predictability across future projects.

### 5.5 Industry Impact and Standardisation Opportunities

The wider construction industry stands to benefit significantly from standardising macro-micro planning interfaces. The MM-PIP addresses a long-standing gap in most contract and control frameworks: the absence of a clearly defined level-of-detail protocol.
Standardising this interface would:

- Enhance schedule reliability across multi-contractor projects.
- Support consistent client and stakeholder reporting.
- Reduce rework in data reconciliation; and
- Provide a repeatable model for digital project delivery.

Governments and major infrastructure agencies are increasingly mandating structured planning frameworks aligned with ISO and AACE standards (IPA, 2021; Transport for NSW, 2022). The MM-PIP could serve as a benchmark model for future guidance on integrated planning and reporting standards.

### 5.6 Future Research and Development

While the MM-PIP demonstrates strong benefits in a large infrastructure context, further study could explore:

- Application in smaller-scale or fast-track projects, where resources for detailed integration may be limited.
- Automation of data exchange between P6 and Aphex using APIs or middleware.
- Integration with machine learning and predictive analytics, allowing real-time risk forecasting and performance trending.
- Development of industry training frameworks to embed macro–micro interface principles in professional accreditation pathways.

Future research should also investigate how this protocol interacts with contract administration systems, BIM coordination environments, and digital twins to achieve holistic digital integration.

## 6. Conclusion

The integration of macro and micro planning systems represents one of the most critical yet underdeveloped aspects of modern construction project management. This paper has demonstrated that inconsistent levels of detail, unstructured data flow, and lack of clear governance between planning systems can significantly undermine project control, reporting accuracy, and performance measurement.

The Macro - Micro Planning Interface Protocol (MM-PIP) offers a practical and standards-aligned solution to this challenge. By establishing consistent Levels of Detail (LoD), defining control boundaries between Primavera P6 and Aphex, and aligning the Work Breakdown Structure (WBS) with the Cost Breakdown Structure (CBS), the protocol transforms fragmented planning practices into a coherent, integrated system of control.

In an era of digital transformation, the MM-PIP also strengthens the link between project controls, 4D BIM, and Common Data Environments (CDEs), enabling continuous performance measurement and predictive analytics. When applied consistently, it supports not only operational efficiency but also strategic insight, forming the foundation for data-driven project governance.

The importance of defining and maintaining a clear interface between macro and micro planning systems extends beyond efficiency—it establishes the foundation for trust, accountability, and transparent reporting across project teams. As projects become larger, more complex, and digitally integrated, the MM-PIP framework offers a scalable blueprint for future-ready planning and control systems.

In summary, a well-governed interface is not just a procedural enhancement; it is a strategic necessity. It ensures that all works at the construction front feed accurately into the project's overall performance narrative - enabling teams to control outcomes, not just measure them.

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## Biographies

**Dr Ming Xu** is a Director of X&L Engineering Pty Ltd and an Honorary Senior Fellow in the Department of Infrastructure Engineering at the University of Melbourne. He is a Civil Engineer with over 20 years of experience spanning engineering, construction, project management, and infrastructure investment across both government and private sectors, including major international contractors. He has extensive expertise in the planning, delivery, and post-delivery phases of large-scale infrastructure projects, including PPP, D&C, ECI, and alliance contracts. His professional background includes providing strategic consulting services in project planning, risk management, cost and controls, and procurement for multi-billion-dollar transport and infrastructure programs such as the North East Link, Melbourne Metro Tunnel, Inland Rail, Torries to Darlington, and Suburban Rail Loop. He is also actively engaged in education and research, overseeing vocational training programs in project management, collaborating and investing in R&D initiatives with government and industry partners. Dr Xu's research interests focus on infrastructure procurement, project delivery performance, construction innovation (including materials), energy efficiency and artificial intelligence in infrastructure. He is a reviewer for leading international journals, an Infrastructure Sustainability Accredited Professional, and a qualified Gateway Reviewer for the Victorian Department of Treasury and Finance.

**Dr Bing Li** is a Director of X&L Engineering and Chief Executive Officer of New Momentum Education Group. She is a Fellow and Chartered Professional Engineer of Engineers Australia and a was Committee Member of its Victoria Division. She has over 20 years of experience in the engineering and construction industries. Dr Li has held senior management and technical positions across a range of infrastructure and building projects including roads, bridges, rail, and airports, as well as in digital engineering and virtual construction. She has extensive experience in construction and design management, project planning and controls, risk and commercial management, and the application of 4D BIM and virtual reality technologies. Her project portfolio includes major programs such as the South Eastern Program Alliance, North East Link Project, and the Victorian Transport Standards Taskforce. Dr Li's research interests focus on structural engineering and high-rise building performance, construction innovation, and digital transformation in infrastructure delivery. She has published in leading international journals and remains actively engaged in advancing professional practice through her involvement with Engineers Australia and the National Association of Women in Construction.

**Dr Felix Kin Peng Hui** is an Associate Professor of Engineering Management and an Academic Specialist in the Department of Infrastructure Engineering, Faculty of Engineering and IT, University of Melbourne. He is also the Program Director/Academic Coordinator for the Master of Engineering Management program and the Engineering Business specialisation for postgraduate masters degrees. Dr Hui is an experienced engineer with over 25 years of industry experience in managing continuous improvement projects, factories, and business units. He has held senior management positions in a range of manufacturing industries which includes machine tools, precision engineering and semiconductors. He has also consulted to organisations seeking continuous improvements to optimise their operational efficiency. His research interests are in the areas of operational process optimisation, operational efficiency, lean systems, organisational development and team dynamics in engineering projects. He is currently a lead investigator on several government funded projects which includes mega-infrastructure projects research, prefabricated modular construction research, next generation buildings with Building 4.0 CRC and on CRC-P projects involving end-of-life treatment processes. Dr Hui is a registered Professional Engineer (Singapore), an ASEAN Chartered Professional Engineer and a Fellow of Institute of Managers and Leaders.