

## **Effective and efficient management of project information in the digital era**

Steve Wood

### **Abstract**

The volume of information project teams in the AEC sector have to deal with has increased in recent years, and that trend is set to continue. Workers are suffering from information and communication overload which is distracting them from what will add value and is important. To remain competitive contracting organisations need to provide their teams with tools that drive them quickly and effortlessly to the information they need to inform their actions and guide their decision making. This paper sets out a proposal as to how the data silos and manual processes encountered in a typical contracting business can be transformed by the implementation of a common project information management platform with automated workflow processes and real time reporting driven from underlying data, to eliminate unnecessary administration tasks and manual reporting processes and make it easier to obtain timely, complete and accurate information.

### **Introduction**

A survey undertaken in 2008 by IDC projected that the volume of information either created, captured, or replicated in digital form would increase from 281EB (Exabytes) in 2007 to reach nearly 1800EB by 2011 (Wiggins, 2012). This general trend in the increase of information volumes is mirrored in the AEC sector. It is easier to create revisions to design information than ever before, leading to greater volumes of amended design documentation. E-mail provides an instant means of communicating a message, making a request, or issuing a document, so it proliferates, and has largely, but not completely, taken the place of traditional hard copy correspondence. Information is the lifeblood of an organization (Wiggins, 2012), and equally so for a building project, not only to ensure that the right thing is built on site in a timely manner, but also to ensure that full monetary and time entitlement is secured from the customer and to defend claims from other parties up and down the contractual chain.

The increase in speed of communication and the volume of information being created has resulted in an increase in expectations as to the pace at which people work, making it more difficult to keep up to date with the latest position and on top of all the actions that require a response. Yet, typically we have answered this seismic shift in working practice by adding new applications and processes to supplement existing rather than re-engineering the way we tackle the challenge of information management for the digital era. People have more choice as to where they store their documents, resulting in an information archaeology rather than an information architecture (Lappin, 2010). In the words of Barak Obama, “we cannot meet 21st Century challenges with a 20th Century bureaucracy” (Nomination Acceptance Speech, 28 August 2008).

This state of affairs is endured by a workforce constantly under pressure to achieve more with fewer resources to ever tighter deadlines. To have any hope of delivering on this demand an organisation must give their workforce the most effective and efficient processes embedded within the best tools to support them.

This report sets out the current information and document management problems within a typical contracting firm in the AEC sector, together with proposals as to how this challenge could be overcome.

### **Trends in document and information management**

Historically the work flow processes of the AEC sector have been based on the origination, sharing, amendment and approval of documents. We are slowly moving from an industry centered on managing documents to managing information. The most significant shift in this direction is the move towards Building Information Modelling (BIM), where documents, such as specifications, drawings, etc. are being replaced by information in a data model, but other common processes are also affected by this trend, examples include snagging lists being replaced with tablet based applications that feed data into a central database and site attendance records replaced with database entries driven from biometric scanners.

In the long term we are likely to see the convergence of these tools to provide the end user with a “one stop shop” for management of project information, but for now we live in a world where projects are at different stages on this developmental continuum, and the reality is that we need a flexible toolset that is as able to deal with documents and email as it is with data from a BIM

model or other source, such as a snagging or time and attendance tracking system, but bring these disparate sources together to present them to the project team and business managers as a cohesive whole.

As well as the shift from managing documents towards managing information we are also seeing a change in the way people originate and access documents and information. There is a move towards a multi-device environment where people will switch between different devices throughout their day as noted by Klinc, Turk & Dolenc (2009). Someone may deal with emails and start to draft a document on the bus or train on the way in to work on their tablet, but then finish the document and send it via their laptop from the office. Later in the day they may need to refer to the document when travelling to a meeting and do so on their smartphone. There is an expectation by workers that they will be able to access what they want, when they want it, where they want it.

A further move is noted towards the use of dashboards to provide users with real time status information, driving them to what is important. Increasingly these tools are visual aids rather than text based reports. Few (2013) states that 50% of the brain's resources support visual processing and approximately 70% of the sense receptors in our bodies are dedicated to vision, leading to the conclusion that "how we see is closely tied to how we think". This suggests that providing users with real time, good quality, dashboard reporting will produce significant benefits to an organisation over more traditional text based reports.

### **Information for decision making**

Directors and senior managers of a construction organization typically need to surface high level and detailed status information to inform their actions, answering queries such as *where are we with design sign off?*, *What information is outstanding from the design team?*, *What activities are behind/ahead of programme?*, *What labour resources have we had on site from x subcontractor this week? How does that compare to what we were expecting?*, *Where are we with submission and agreement of the variation account?* The questions that need to be answered to manage a project or a construction business tend to remain fairly constant regardless of the size and complexity of the project and regardless of the way information is being managed on that project. Sikazwe (2008) notes that the lack of standardization of processes means that people spend more and more time looking for information and less and less time exploiting it.

A toolset is therefore required that enables surfacing of the relevant information to answer those questions in a timely and efficient manner regardless of how and where the documents and data are ultimately held. The answers need to be capable of being surfaced with the minimum of manual intervention, to enable the project teams to spend their time solving problems and dealing with issues that will determine the success, or otherwise, of the project rather than trawling through documents and data to find the information needed to answer those questions for themselves and producing reports to communicate their findings to others.

### **Typical information architecture landscape within a construction company**

Figure 1 sets out a high level representation of the information repositories of a typical construction company, with many disparate data silos. Information is (a) held in a variety of media: hard copy; structured data (in-house and 3<sup>rd</sup> party database systems); unstructured data (word-processed documents, spreadsheets, image files, etc.); (b) spread across multiple locations: project offices; regional/head offices; 3<sup>rd</sup> party data centres; and where held in digital format (c) stored on a variety of platforms: local hard drives; network file shares; 3<sup>rd</sup> party server; private/public cloud services, each with their own user access setup and protocols to be managed.

Often each digital resource has to be accessed using separate login information and the data in one system cannot be easily cross related to data in another system, leading to re-keying and multiple sources of “truth”. Typically it is either not possible to access information easily across multiple end computing form factors (smart phone, tablet, PC/laptop), or the user experience is unsatisfactory on one or more of them. This landscape reflects the “islands of automation” as described by Hannus, Penttila, and Silen (as cited in lecture by Dolenc September 2014).

# The Problem

Many Data Silos

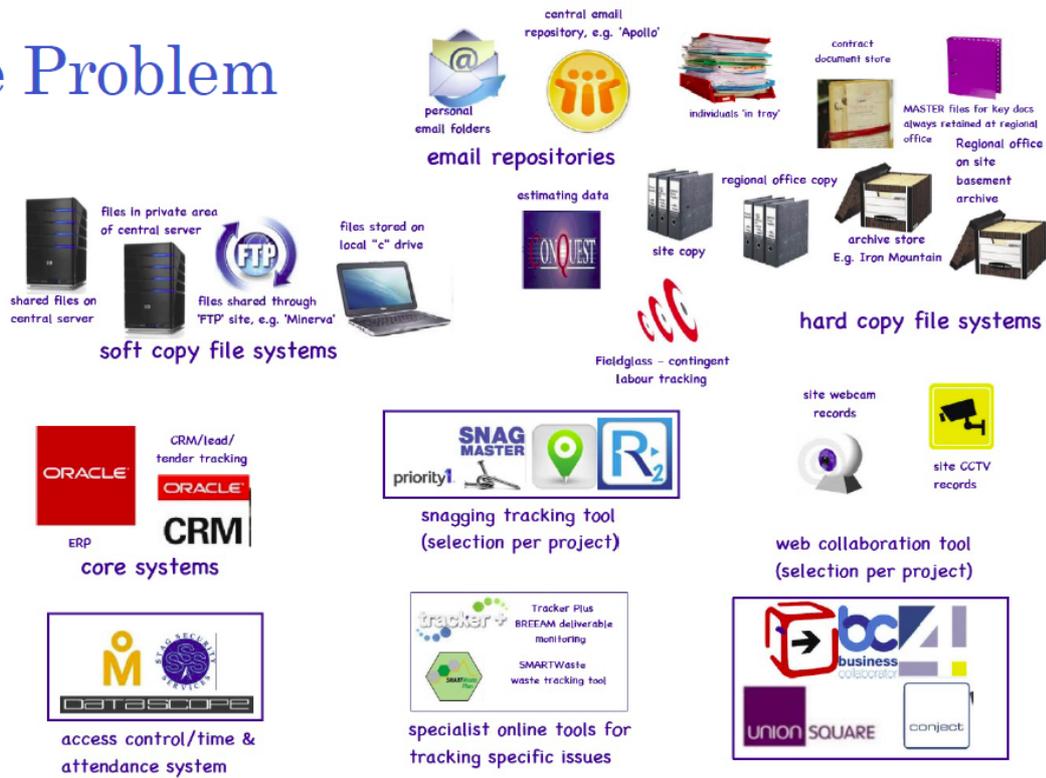


Figure 1. Illustration of information system silos within a typical contracting organization within the AEC sector.

## Hard copy and digital information

Since e-mail became a tool available to everyone in the mid to late 1990s digital methods have largely taken over from paper, but there remain some processes within the AEC sector that remain primarily paper based. In particular this includes legal and contractual documents (e.g. executed contracts, warranties, final account agreements, formal notices, claims letters, etc.), and in a multi-party project delivery team there are often those who still cling to the old ways of working – hard copy letters, etc. Project teams therefore have to manage and refer to mixture of hard copy and digital documents, which can result in difficulty in gaining a complete view of an issue in one place, e.g. a complete correspondence trail with a project party.

## Network file shares

Users often store documents they originate on their own laptop or personal area on a network drive as they are nervous, often with good reason, that their colleagues may either accidentally or

deliberately modify, move, or delete their work, rendering them unable to access the original. Storing documents in private repositories prevents other users from accessing these documents directly, unless a copy is also posted on a shared resource accessible to all project participants, however, this then creates a further problem of multiple copies of the same document having to be kept up to date, which often doesn't happen consistently, so it's not easy to determine where the latest information can be found.

Network file shares typically don't provide for version control of documents, so each version is a separate file in its own right, leaving users to establish and manage their own filename notation for recording revision details. In a multi-user environment there is a tendency for everyone to do their own thing with this, but even if a protocol has been established it is difficult to enforce as its success relies on every individual understanding the protocol and adhering to it, when it is often easier not to.

### **E-mail**

E-mail has become the *de facto* standard for communication in the AEC sector. Even in circumstances where collaboration portals are in place on projects it is often the case that they are used primarily for storage and workflow tracking of design documentation, but are viewed by project participants as cumbersome for day to day informal communication, and the domain of the document controller, so e-mail prevails as the primary communication medium between project participants both within and across organizational boundaries. Email is usually delivered instantly, and can be sent and received on the move, which is a great advantage in the AEC sector, where workforces are distributed widely and are often on the move either on or between sites.

The issue and receipt of documents via email is commonplace, but leads to difficulties in tracking those documents. For example, to locate a particular document that was issued by email some weeks ago that has not been detached and stored in a structured file repository, it is necessary to have a good idea who sent it, and when, or at least recall some key information that was in the email that issued it to enable a search to be conducted. This can be particularly difficult where a document is received into the organization via an email to one individual, who then goes on to forward it to other members of the project team. For the other team members to locate the document it may seem obvious who outside the organisation issued it, but they are less

likely to recall which one of their colleagues received and circulated it, and therefore locating the document is time consuming. If the document issued as an attachment to the email has been detached and stored in a file repository (e.g. network files share) it is more likely than not that it has been disassociated from the issuing email, any associated commentary that went with it, the date it was issued, and by whom, etc. making it very difficult to re-associate this information should it later prove necessary for some contractual dispute, for example.

Restrictions placed on incoming and outgoing email servers can make sending large files by email a hit and miss process, one attempt at sending often leads to another attempt at breaking files down into batches to get them through the restrictions, which is time consuming and frustrating for users.

### **User selection of project toolset via 3rd party providers**

Sometimes software products or Software as a Service solutions are deployed to automate particular processes, such as snagging, BREEAM tracking, time & attendance management, time lapse web cam imaging, etc., but these are typically deployed on a project by project basis with decision to deploy and selection of tools driven by the knowledge, experience and preferences of the most computer literate and vocal members of the project team.

Typically the implementation activity is driven by project staff as something sundry to their day job, so their primary focus is on what the toolset can do for their particular job function needs rather than those of the wider team/ organisation, and minimizing deployment cost to the project, with scant regard for aspects such as a robust backup regime, information security, data protection, capture of data in a way that makes it useful to all members of the team, consolidation of data for cross project reporting, archiving upon project completion, etc.

Procuring and setting up such tools successfully can take a great deal of effort and involve a learning curve, which means that procuring and implementation on a project by project basis is time consuming, inefficient and therefore costly. It also reduces the likelihood of time and effort being spent on integrating the particular application into the other information management systems operational on the project to enable a cohesive view of the project data to be presented to the project team members.

Figure 2 sets out in concise summary form the key issues in the management of project information that are typical in today's AEC sector companies.

Current systems/practice	Problems that arise from current system/practice
Documents stored in a mix of hard copy and digital formats and across many information silos	<ul style="list-style-type: none"> <li>• don't know where to look/can't find things easily</li> <li>• difficult to ensure robust backup of data</li> <li>• managing archival and disposal is complex due to volume of information repositories</li> <li>• much duplication of effort through re-processing data and managing multiple versions</li> </ul>
No structured version control on documents stored on shared network drive	<ul style="list-style-type: none"> <li>• lack of clarity on what is the latest version</li> </ul>
Documents often issued/received by email	<ul style="list-style-type: none"> <li>• don't know which email has the document attached - needle in a haystack</li> <li>• if email wasn't copied to project repository do team members know it exists and can they get to it directly or do they have to ask others for it?</li> </ul>
E-mail records stored separately to other project records/documents/correspondence	<ul style="list-style-type: none"> <li>• no consolidated view of correspondence – difficult to track the trail of a particular issue if stored in multiple locations/across multiple media types</li> </ul>
Cross reference lost where documents detached from email to a network folder	<ul style="list-style-type: none"> <li>• no audit trail as to when a document was issued and by whom</li> </ul>
Sharing digital files too large to email across organisational boundaries is often done via CD ROM or FTP site (or similar)	<ul style="list-style-type: none"> <li>• often no robust audit trail of what was issued to whom and when</li> <li>• if attempted by email was it received, does it need to be sent another way?</li> <li>• delay whilst waiting to see if email was successful or file was too large</li> </ul>
Workflow processes managed on “dumb” digital documents, i.e. no automation	<ul style="list-style-type: none"> <li>• Difficult to determine latest status of a document/issue in a workflow</li> </ul>
Digital files/project email repository located on central servers not accessible to mobile devices of most staff	<ul style="list-style-type: none"> <li>• inability for most staff to access documents/data 'on the move' or when in meetings</li> </ul>

*Figure 2. Summary of the current systems and practices found in many AEC companies today and the problems that arise from them*

## Objective

Good project technical and management staff is an expensive resource, represents a large proportion of the direct cost of running a contracting firm, and in the current climate is hard to come by. Providing these teams with business processes and toolsets that drive out wasted time

and effort, and give them the information they need, when they need it, with the minimum expenditure of effort, is essential to improving and maintaining competitive position in the marketplace.

To survive, or better yet thrive, in this more competitive environment, the mantra for any CEO should be, “Deploy, innovate, and propagate”: First, deploy a consistent technology platform. Then separate yourself from the pack by coming up with better ways of working. Finally, use the platform to propagate these business innovations widely and reliably. (McAfee & Brynjolfsson, 2011)

Ross, Weill & Robertson (2011), set out a compelling argument for establishing a “foundation for execution”, whereby core processes are established on a common technology platform across the business, automated and honed to be as efficient as possible, providing a solid, stable base for agility in other areas of the business.

Having identified the key inefficiencies in existing systems, the objective of this proposal is to present a *foundation for execution* model that will substantially reduce staff costs through improved efficiency of process and increased certainty of project outcomes, and then to deploy it consistently across the business. It will cover all phases of the lifecycle of document management as laid out by Cannon, N., Defoe, P., Pittard, S., Saunders, H., Sell, P., Winterkorn, E. (2009): (1) creation/capture (2) share, collaborate, control, (3) index, manage, store, (4) access, retrieve, distribute, (5) repurpose, (6) archive, delete.

The core principles underpinning the objective can be summarised as:

- Implementation of a unifying system that brings together digitised paper based records, email and digital documents and structured project data held both within and outside the core application to present a cohesive whole to the project participant;
- Provision of a flexible digital toolset on a common platform that can be deployed or modified at short notice with relative simplicity in a cost effective manner to meet the changing needs of the project, business unit and organization;
- Elimination of “dumb” documents (typically word, excel, PDF), and replace with intelligent templates that:
  - have embedded filing references enabling automation of the filing process;

- route automatically based on business process logic where no user choice is appropriate, or provide lookups from a contacts database where users may direct the routing;
- completion of form fields where appropriate from data held in the database (e.g. project name/number, originator name/contact details, etc);
- capture of form input data directly into database for reporting and scheduling purposes;
- Elimination of unnecessary manual thought processes and intervention where it is possible and appropriate to replace them with automated processes, enabling the workforce to concentrate their efforts where they most add value to the business;
- Providing real time graphical dashboards driven from underlying data to eliminate manual trawling for information and writing of reports;
- Establish a common communication platform for communication at project level with the supply chain, automating processes across organisational boundaries and reducing the reliance on email.

The principal changes that project teams and business managers will see as a result of the implementation of the proposal include:

- All documents to be available and fully searchable from within a single digital repository regardless of their point of origin or whether they are also held in hard copy form for legal/contractual purposes, making it easier to locate documents and their contents;
- Reduced manual effort to ensure that documents are filed and distributed correctly;
- Improved clarity as to the latest version of a particular document;
- Ease of sharing documents within and outside the organisation from their source location irrespective of file size, whilst maintaining appropriate security controls;
- Enabling fast and easy access to all documents to which staff should have access from any location and any end point device (PC/laptop/tablet/smartphone);
- As a by-product of user action, recording, and making available to project staff, a full audit trail of distribution/access of documents;
- A reliable and complete backup regime;

- Real time visual dashboard reports driven from underlying documents and data, thereby eliminating manual work to track workflow status and produce reports to update others;
- The re-use of information from its source location instead of continued re-keying of the same information into different systems and documents for different purposes;
- The implementation of a structured archival and disposal process covering both digital and hard copy information.

### **Proposed solution**

The solution I am proposing to address the problems outlined above is the implementation of an application provided by Union Square Software, called Workspace. It consists of a SQL server and separate file store, which forms the core portal product providing a common enterprise wide repository for all project documentation. Sitting alongside the core portal will be a separate extranet consisting of an Essent database and persistent file store, which enables those in external organisations to publish their own content directly into the Union Square platform, and to access content which has been published to them by people within the organisation, yet providing a high level of security for documents and data located on the core portal as it is behind the enterprise firewall. Users within the organisation can access a seamless view of all information held both within the core portal and the extranet through a single interface, presented through a unified view.

The product is capable of being deployed on premises, or hosted in either a public or private cloud environment. In this instance I would propose the use of a private cloud installation, where the data is stored in a highly secure data centre with robust fail-over arrangements.

The implementation will provide functionality that replaces all of the following current repositories and applications:

- Central email repository
- Network file shares (both private and public folders)
- Local hard drive storage (other than content synced with Workspace for offline working)
- File Transfer Protocol sites

- Hard copy general filing systems both on site and in the regional/head office (retention of some key contractual documents would remain for legal reasons, but all such documents would be scanned and made available to users digitally)
- Off-site general filing archive storage
- Hard copy “in-trays” – with all paperwork being scanned at source, documents for action will be routed digitally
- Multiple external web collaboration platforms

The access needs of the end user will be different depending on the type and speed of internet connection available to them and the type of device they wish to use at any particular time to access the system. Regional offices typically have a high bandwidth network connection that provides fast access to the data centre, but for project offices where the connections are not so robust cache servers would be provided to ensure a responsive user experience. For users operating from their mobile devices and laptops in other locations bi-directional sync of key data to create a local copy on the device is possible.

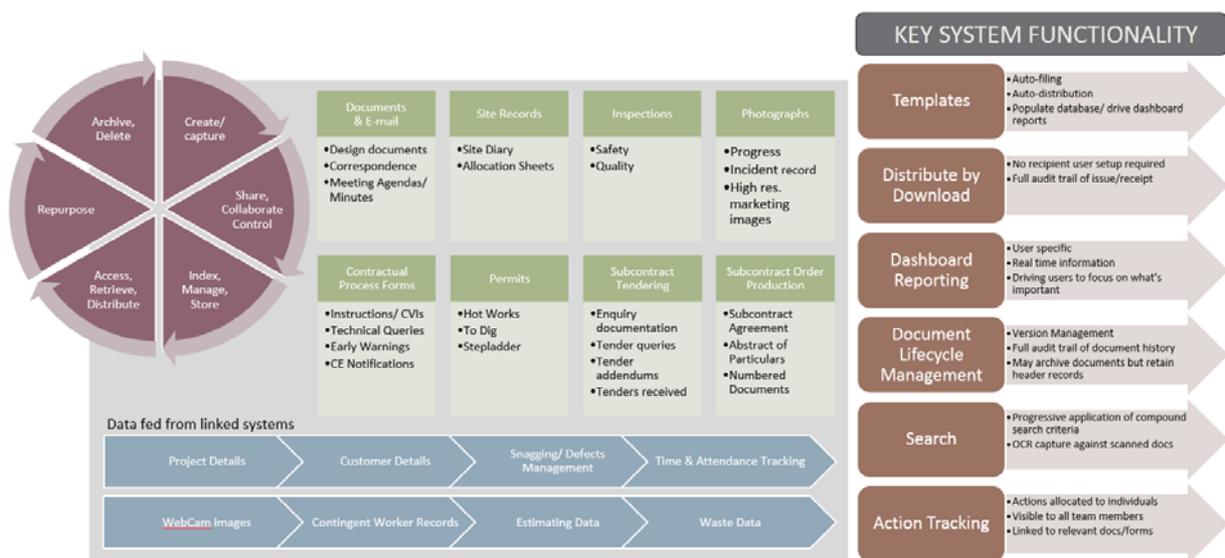


Figure 3. Overview of proposed solution scope and function

## **Union Square Workspace - key functionality**

The key functionality of the Workspace platform relevant to the objectives that have been outline above can be summarized as follows:

- Single repository for emails and documents, with the ability to display one or other, or both in a single integrated view;
- All updated documents will be automatically stamped with a revision number as they are amended, with a full copy of all revisions retained, thereby ensuring that if another staff member updates a document the originator can always get back to their previous version;
- Plug-in for Microsoft Outlook that allows quick and easy transfer of email from a users own mailbox into the central repository, and even allows the repository to be viewed from within Outlook, thereby providing seamless integration from the user perspective, which will assist in driving adoption;
- Files received by email may be detached and stored in an appropriate place in the file repository (e.g. Programmes received from subcontractors may be stored in a “programmes” folder), but a link is maintained between the file and the email such that each can be quickly and easily accessed directly from the other.
- Local working folder on users laptop/PC which is synced with Workspace when connected to the network, thereby allowing creation and modification of documents off-line;
- Capability to access the complete file repository regardless of device form factor – PC/laptop, tablet and smartphone, and across all major operating systems (iOS, Android and Windows)
- “Intelligent” template based forms:
  - automated data population from information held in the database, e.g. when creating a new instance of a form from within a project filing area the project name and number are pre-populated, as is the originator, using the association with their login credentials;
  - automated workflow routing of a particular form: where routing must follow a set path it is fully automated upon submission of the form; where there is choice as to where a form is routed the user may select from address book entries in the database or enter email addresses;

- Distribute by download: users within the enterprise may issue one or more documents both internally and externally to the organisation (regardless of file size) as a download link;
- User configurable dashboards to surface relevant real time information driven directly from the underlying data

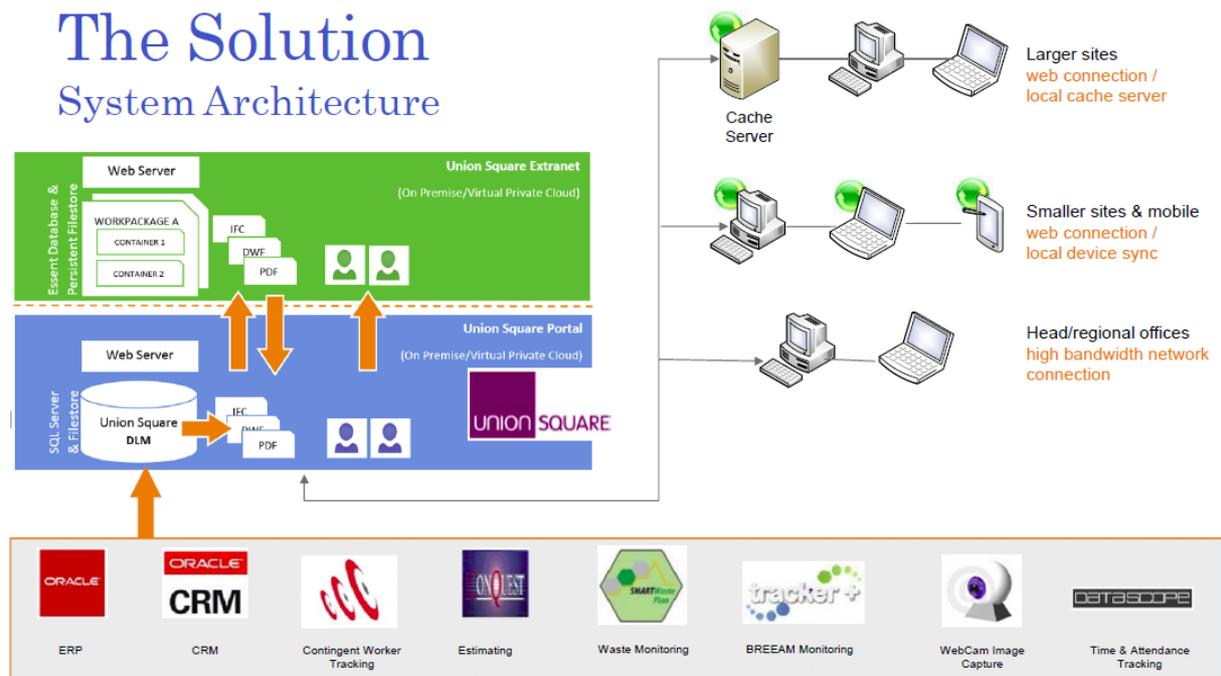


Figure 4. Proposed system architecture

### Interoperability

Workspace has an Application Programming Interface (API) that allows quick and easy integration with other applications, and the foundation of a SQL Database facilitates more complex integration not catered for by the API. Whilst this implementation would replace a number of platforms and applications with a single integrated product there would remain a need for some specialist applications to operate alongside Workspace, such as ERP, CRM, time & attendance systems, etc. to meet specific business and project requirements. Some of these would operate across the whole business (ERP, CRM, etc), others would be selected to meet the needs of particular projects (snagging, time & attendance, etc). Where application deployment is dependant upon project requirements it is intended that there would be an approved list for each type of product to narrow down the number of products deployed within the company, thereby

making it more cost effective to spend time and effort on enabling interoperability of those products with the core foundation to present them to the user as a cohesive whole.

### **Conclusion**

Ross and Weill argue that new systems alone have no value and that value derives from new or redesigned business process (Ross & Weill, 2011). I believe there are three essential elements to ensuring the success of the implementation of this proposal: (1) business process re-engineering, coupled with (2) appropriate software deployment and (3) buy-in from the workforce, achieved through engagement to demonstrate the value of re-engineering the business process and implementing the software, and training and supporting them to derive maximum value from the project investment.

Implementation of the above proposal will provide a solid foundation for execution in respect of the core information management processes that are so essential in a contracting organization in the AEC sector, and provide those who work in the organization with a robust and reliable toolset which enables them to focus on high value activities rather than becoming distracted by unnecessary administration.

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