The Thesis Committee for Mark Eugene Emanuel
Certifies that this is the approved version of the following thesis:

Effectively Managing Multi-Source, Multi-Site Technology Deployments

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor: ______________________________
Steven Nichols

Co-Supervisor: ______________________________
Tommy Darwin

Effectively Managing Multi-Source, Multi-Site Technology Deployments

by

Mark Eugene Emanuel, BSME

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Abstract

Effectively Managing Multi-Source, Multi-Site Technology Deployments

Mark Eugene Emanuel, MSE

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Supervisor: Steve Nichols

Co-Supervisor: Tommy Darwin

Information Technology infrastructures continue to be dynamic, evolving, and business critical investments for companies of all sizes. Even with moves to virtualize end user computing functions, the evolution of network architectures, mobile computing devices and corporate security requirements will continue to necessitate technology upgrades requiring, at their core, the rudimentary act of placing hardware at specific physical locations on a prescribed timeline. In distributed corporate environments, deploying a range of devices sourced from multiple suppliers into geographically dispersed locations can be a challenge in material management and logistics planning. This Multi-Source, Multi-Site style of deployment is a complex balance of competing timelines where failures to meet delivery targets can have costly impacts that cascade throughout the project. Perturbations in global supply chains, manufacturing schedules, and local shipping capacities drive fluctuations in a supplier's ability to consistently and

predictably execute to delivery timelines so it is the task of a deployment Project Manager to interpret a variety supply chain signals and take action to minimize the negative impacts of supply chain challenges. In that effort, the deployment PM will benefit from a structured approach to defining how available supply chain data will be used to help manage expectations, monitor execution, and effect the overall deployment success.

In this paper, I present an approach that breaks deployment planning into 3 primary deliverables; the Site Plan, the Data Plan, and the Monitoring Plan. Executing those three plans will drive a PM to understand the supply chain data available to them, translate that data into information useful and understandable by all stakeholders, and monitor the progress of the supply chain against a deployment schedule. In practical terms, those plans culminate in a data mining and data management methodology that can be supported with spreadsheet based dashboards that provide both a fixed Snapshot of the status of the deployment as well as a rolling Timeline of key material movements over the duration of the deployment.

The data management approach described here is specifically designed to avoid complex macro development, database queries, or software purchases that may not be available to all Project Managers. Applying the Multi-Source, Multi-Site approach, a PM can gain useful and relevant information from various streams of supply chain data using straightforward spreadsheet manipulations. With a clearer picture of supply chain execution, a PM tasked with a Multi-Source, Multi-Site deployment can better leverage project change control methods to improve their chances of successfully meeting their schedule and cost targets.

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Chapter 1: Introduction

DEPLOYING NEW TECHNOLOGY

Technology infrastructure throughout today's business environment is ubiquitous, critical, and dynamic. A significant portion of the Total Cost of Ownership of a business IT infrastructure comes from the management, maintenance, and support of an installed network. IDC Research (Healy, 2010) shows that the average deployment cost alone is $615 per PC, and costs exceeding $700 are not uncommon, as compared to business class desktop PC list prices of $450-$615[1]. As technology advances and demands on the IT systems change, firms will periodically be challenged with upgrading components of their infrastructure. Historically, firms will refresh their computer technology every three to five years to take advantage of improvements in technology, security, and efficiency (Beck, 2011). Slow economic recovery after the 2008 recession has had an impact on frequency of PC Technology refreshes (Williams, 2011), but IDC expects that a large portion of businesses will upgrade their PC base as the economic recovery develops (Healy, 2010). These upgrades can take many forms, but one approach is to execute a bulk upgrade of multiple, diverse devices across multiple sites/campuses. This may be limited to periodic upgrades of end-user computing devices such as desktop computers, notebook units, and mobile devices, or it may be an enterprise wide refresh of a broad range of technology devices (Healy 2010, Beck 2011).

Driven by the complexity of modern enterprise level IT infrastructures, even a bulk replacement of homogeneous devices (for instance, a desktop PC refresh) at one

[1] Dell.com and HP.com advertised prices, July 2011

business site carries enough complexity and risk to warrant a fully defined Project Management approach (Insight, 2005). When multiple devices are replaced in a heterogeneous environment (Desktops, notebooks, servers, printers) across multiple, geographically dispersed business campuses, the risks and challenges are quickly compounded. One underlying requirement in any of those undertakings is to ensure delivery of the right hardware, in the right quantities, to the right locations, within the correct timeframe. Complexities in IT architecture, hardware and software configuration, technology selection, cost analysis, data management/transfer, and host of other challenging design considerations surround a Multiple-Site technology refresh (Dell, 2008), but at some point in the project execution the gear must arrive in a manner that can be utilized by the technicians or users responsible for completing the deployment. The inability to properly manage material movements in support of a deployment can quickly destroy a project timeline.

Table 1, from an IDC white paper on Deployment management (Healy, 2010), demonstrates some of the different tasks and complexities across different deployment plans. Note that, in Table 1, the material movements described above are contained in the "staging and Logistics" phase of the various deployment models.

	Basic No documented or repeatable process	Standardized Documented manual process	Rationalized Documented and mostly automated	Dynamic Fully automated, end user could perform
Deployment Management	PCs deployed as "one-off", not project	Project managed. Deployment script for technicians	Deployment projects consolidated by locations. Formalized BPI Continuous Improvement	Central deployment management system linked to CMDB and technician dispatch
Staging and Logistics	Multiple legs for warehousing and staging	Central staging <2 week supply chain	Staging only for remote users	JIT ordering - product moves directly from OEM to user
Imaging	No central image standard	Centralized image, may be deleted on arrival	Centralized image with quarterly updates	Cross-platform image Dept overlays Load in factory
Applications	Load from CD or network share	ESD System covers <25% of apps	50-90% Packaged Departmental Apps	90%+ Packaged Integrated entitlement
User State Migration	Files copied manually	In house tool moves data, settings are manual	Off-the-shelf tool move data and settings	Simple enough for end user to run
Day After User Support	No proactive process	Onsite technician answers questions	User FAQ, augmented helpdesk, on call support	Remote issue resolution from command center

Table 1: Overview of Various Deployment Models

The optimization and globalization of computer manufacturing supply chains over the past decade has added to the challenges faced in coordinating a large, multi-site technology refresh in many ways. Significant portions of PC and Server manufacturing have moved to 3rd party manufacturing partners that support supply chain operations for the major OEM brands (Hewlett Packard, Dell, Lenovo, IBM) (Atallah, 2011). These contract manufacturers leverage low-cost or regionally critical geographies (Mexico, China, Poland, etc) to provide a cost advantage for the OEM's, but the global aspect of the supply chains also introduce challenges in managing the supply chain signals related to tracking, consolidating, and managing large volume equipment purchases (Evrard-

Samuel, 2008). Basic components may move through multiple consolidation and distribution centers before they actually leave the OEM for final delivery to the customer, and the demand and supply chain signals that drive those material movements can become distorted (Askegar, 2004). Visibility to the intricacies of those material movements can be challenging, even for project managers within the OEM's. Peripheral devices that are necessary for successful technology deployments (server racks, specialized monitors, notebook security devices, uninterruptable power supplies, surge protectors, etc.) may also be sourced through the primary OEM as part of the complete technology refresh plan, even though they do not carry the OEM Brand name[2]. Those peripheral devices can move through parallel, but entirely separate supply chains managed by vendors and suppliers under reselling contracts with the OEM's. This variety of supply chains allows cost optimization by device or class of device, but it adds to the complexity faced by a Project Manager trying to coordinate complicated material movements.

In the simplest logistics scenario for a project manager, a multi-site technology refresh can be managed by moving all of the required hardware into a centralized warehouse facility and drawing from that facility to deliver custom packed "kits" to each deployment site that exactly meet the overall deployment project plan. Moving the material to a consolidation warehouse prior to executing the refresh, though, can be extremely costly compared to the cost of direct shipping material from the OEM and vendors to the target sites. In the end, the project manager is typically faced with a Cost/Benefit decision on what material can be pre-ordered and warehoused, what should

[2] Example: Dell.com lists 1403 products from 79 vendors under Enterprise Class Networking

direct-ship, and what level of interaction/support/control will the OEM supply chains be responsible for (Dell, 2007).

Regardless of the decisions made in structuring a complex deployment, there will still be an underlying requirement to monitor material movements in order to support a defined deployment schedule. This underlying material management requirement will be the focus of the remainder of this paper. Specifically, I will present a deeper discussion on the challenges of managing material that is sourced through a variety of supply chains in a coordinated effort to execute technology hardware deployments to multiple customer sites. Moving forward, I will refer to this style of deployment as a "Multi-Source, Multi-site" (MS-MS) engagement.

DEFINING THE SCOPE

As described above, a Multi-Source, Multi-Site deployment can take a wide variety of functional forms, execution timelines, and distributed responsibilities. For the purposes of discussion, I will further narrow down this critical evaluation to examine a style of MS-MS deployment where the individual site deliveries are the responsibility of a single Project Manager working within the OEM. This is a role that exists today in Dell Inc. that the author is intimately familiar with, and serves as a source of practical experience as well as a test bed for evaluating potential approaches to the problem. That OEM Project Manager works in tandem with the customer Program Management Office (PMO) in order to deliver material in a sequence defined in the customer provided deployment plan. There are multiple variations to the OEM PM role, but this basic structure will serve as the foundation for this paper.

From the viewpoint of the OEM Project Manager ("OEM PM") tasked with an MS-MS deployment, the general problem statement is this:

"How can a PM best leverage available supply chain information to ensure a high degree of success in meeting the customer's deployment requirements?"

To address that question, I will present in this paper the following:

- A Case Model that represents Real World situations currently faced by Project Managers in this role today
- An Example, using that Case Model, that more clearly demonstrates the challenges in the PM tasks and the limitations of generally used project management approaches
- A review of literature relevant to the concepts of supply chain management, project management, material management, and data mining
- A detailed dissection of the common supply chain data hierarchies and data elements that are available to the PM
- Proposed methods that can better empower a PM to successfully leverage available data in a dynamic, real world environment
- Analysis, using modeled deployment data, demonstrating the effectiveness of the proposed methods in solving various aspects of the material management problem

Chapter 2: The Case Model

THE TYPICAL MS-MS SCENARIO

I will use the following case model as a baseline to illustrate the current challenges faced by a PM in executing a Multi-Source, Multi-Site technology deployment. Each of the elements in this case model are taken from actual deployment activities that the author has been involved with, either as a PM, a PMO Manager, or a supporting actor. Elements of different deployments have been combined into this case model to illustrate many different nuances and issues that a PM may encounter over various engagements. No one actual deployment may contain all of the case model elements, and each actual deployment will contain a variety of issues not presented here, but solutions to this baseline case model will apply across a wide variety of different customer engagements.

Case Model - Definition

The fictitious company Data.com is a medium sized business offering data management services in a variety of sectors across a wide geography. This company will serve as an amalgam of the typical customers that Dell and other technology providers support on a regular basis. In this example, Data.com has a geographically distributed workforce of 2000 people, with branch office locations in 25 cities. The bulk of employees typically work remotely (at home, in the field), and leverage the branch offices for support, meeting space, data intensive operations, and IT support for their mobile technology devices ("Smart" phones, Notebook computers). The branch offices have local area networks that support office functions, small scale server/storage units for data hosting, communications, application support, and a variety of administrative and IT support functions. The branch offices typically have 1-3 servers, attached storage devices and related networking gear, fixed workstations for data intensive operations, and end-user computing devices (desktop PC's, printers, notebooks, etc) for 8-10 resident (non-field) employees.

At some point in the life of Data.com, the IT devices in each of the branch offices will need to be upgraded or replaced. A typical process, and one that I will model for this discussion, involves a site-by-site equipment upgrade with the goal of having each site and their supported field employees refreshed with new gear in as little time as possible, with as little disruption to the business as possible. Each site will have different equipment needs, determined by the Data.com PMO and driven by site needs, budget, and corporate standards established by the Data.com Information Technology leaders.

Data.com is responsible, in the case model, for developing and managing the overall site refresh plan. The OEM PM is tasked with supporting the Data.com site refresh plan by managing all aspects of the OEM supply chains to ensure the right material is at the correct location at the right time, enabling on-site technicians to execute the refresh plan. In coordination with Data.com, the PM must establish a material plan to support the refresh in each of the sites, initiate the material purchases/flow, and ensure that all of the gear required for each site is delivered on time and complete. Failures in proper execution can manifest as the following events, all with negative cost/timeline implications:

- Equipment deliveries are delayed and the refresh schedule must be changed

- Deliveries are delayed with little advanced notice and technicians arrive on site with no work to accomplish
- Deliveries are incomplete and technicians must remain onsite longer than planned (or return at a later date) after missing components are delivered
- Equipment arrives too early and the sites are burdened with excess material storage requirements, affecting business operations and exposing the material to inventory shrinkage

Case Model - Challenges

The Data.com case model illustrates several elements that have lead to deployment execution issues in the past, based on the author's experiences. The issues listed here are areas where the improvement in material management discussed later in this paper can have a positive effect.

- Since overall deployment planning rests with Data.com, they also retain responsibility for ensuring site readiness. If sites are not prepared for their refresh cycle, the schedule must be changed and material priorities may need to be adjusted
- Equipment delivered to a Site does not match site requirements and gear must be reallocated to/from other sites to adjust for the errors
- A site may have special delivery requirements not identified prior to shipment, causing delays in execution. Examples include the need for a lift gate truck (no loading dock available), special security screening requirements, very limited dock availability hours, etc.

- For notebook refreshes for a field based workforce, incomplete shipments can have a more profound negative impact. If the Data.com IT infrastructure does not support remote data transfer, the field employee will typically schedule a visit to the branch office to receive his new gear and have data migrated from one machine to another. If any expected gear is not available for pick-up, the employee may need to return, potentially impacting his productivity and availability for Data.com customers
- With multiple small branch sites supported in sequence, but geographically dispersed, the technicians performing the onsite work will generally not reside at the branch location. If they are travelling from site to site based on a master site plan, any disruptions to the schedule due to inaccurate material support can have potentially large cost impacts resulting from the need to reroute technicians between cities to reach sites that are ready

Appendix A: Project Scoping Framework lists additional questions that Dell PM's use today to scope individual engagements and identify risks. That list identifies additional concerns that a PM may have when tasked to execute a MS-MS deployment.

Current Approaches to Managing the Case Model Deployment

In the Dell Inc. environment, the PM's tasked with the work described in the Case Model are trained in PMI approaches to project management and well versed in the multitudes of internal company processes necessary to drive operational results. Many of the PMI standards are in place to govern a phased project engagement in its entirety. For this thesis, I will again focus only on the material management aspect of Multi-Source, Multi-Site deployments and I will highlight below how current approaches to project planning, execution, monitor and control can affect those aspects.

Planning

Project planning for the Data.com scenario will involve a wide range of variables, dependencies, and relationships that are not directly relevant to this paper. There are several key decisions, however, that can directly affect a PM's ability to leverage the supply chain data streams once project execution begins.

Planning Considerations for MS-MS Material Control

In tandem with the Data.com team, the OEM PM generates a baseline scheduled that allows for normal production cycle times and vendor lead-times for all gear. The material will be sourced from a variety of vendors (Multiple Source) and will arrive at different times and with different variations at each of the Data.com sites (Multi Site). Pre-staging 100% of the gear in a warehouse prior to the first deployment is typically cost prohibitive (storage fees alone affect profitability, and long term storage routinely involves inventory loss as well), so large scale deployments may involve a material plan requiring a critical, minimum amount of material to be staged prior to the first deployment, but additional material is not ordered, and does not begin to move from the multiple supply sources, until after the initial site refreshes begin.

The challenge is ensuring the MS-MS material deployment plan remains on track to coincide with the technician schedules. If deviations are required, they must be made with enough advanced notice to alter technician schedules without incurring additional costs (re-routing people or gear from one site to the next, changing flight plans close to departure times, etc…). The schedule must include enough buffer time to allow for variations on the outbound shipment cycles of the OEM. If there is not enough buffer and a delivery is delayed, the PM is faced with the potentially costly error of having technicians on site without the gear needed to complete scheduled work. If too much buffer is scheduled, the overall project timeline may be unacceptably long and hardware may dwell too long at a customer site prior to installation, giving rise to shrinkage and potentially disrupting operations at the site. Similar scheduling considerations are needed to ensure Vendor supplied, non-OEM equipment is in position at each site at the appropriate time. These components may follow delivery leadtimes that are vastly different than the primary OEM material, so care must be taken in accounting for shipping and transit schedules for all varieties of hardware. Incorporating these considerations into the final Deployment Schedule can result in a Site Plan that meets the Data.com site schedule requirements with enough flexibility for the OEM PM to deliver equipment on time at each site, without incurring excessive warehousing costs.

Potential Planning Pitfalls for MS-MS Material Control

In addition to the schedule development described above, agreements should be made in advance in several other areas related to material management and hardware procurement. These aspects of a deployment may have limited impact on physical material shipments, but errors and omissions can lead to long term invoicing and collections issues from all parties and may require extensive data mining and management to correct later in the project.

- Ensure the Customer definition of the site kits (gear required for each site) matches in every detail the OEM PM picture of each site kit. Incorrect assumptions here can lead to delays and excessive costs once the deployment begins
- Understand what form the customer Purchase Orders will take. One PO per site? One PM per product type? One single, blanket PO? As we will see later, breaking the customer PO down into workable manufacturing and vendor orders can be a source of error
- Agree on standards to be met in order to say that a site deployment is "complete" and accepted by the customer. Will the old assets need to be removed by the installation team? Is the OEM responsible for packaging/trash removal?
- At what point does the customer take title and responsibility for the hardware? Upon delivery? After installation is complete? Some number of days after installation, to account for burn-in, DOA's?

Execution

The execution phase of the Case model, from the PM perspective, starts based on a timeline that identifies when initial orders will be placed for material. Once that material is ordered, the PM is tasked with managing the delivery of that material as well as initiating additional orders for sites later in the schedule. To execute properly to the prescribed schedule, agreements must be in place between the customer and the OEM PM on how and when to release orders. Depending on the definitions and agreement established during the planning phase, the OEM may not have the authority to order gear for the customer until additional PO's are submitted to the OEM. This requires a high level of coordination where the customer and OEM PM work in tandem to identify when follow-on orders are needed and transfer the paperwork/authorization needed to commit those orders. At the other extreme, the customer may have committed a blanket PO to the OEM, giving them pre-authorization to place all of the site orders. In that instance, the OEM PM can react quickly, but carries the additional risk of inadvertently releasing material to build for sites that the customer is not ready for.

During the Execution phase, the following considerations may have unexpected impacts on material execution

- If the OEM is in receipt of Purchase Orders covering the entirety of the deployment, extreme care must be taken to ensure that enough material, and only enough material, is released to production to support the deployment schedule. Over ordering or under-ordering can both be detrimental
- Care must be taken to ensure that site orders are accurate and complete. manual order entry from a customer PO can be error prone, and inaccuracies in the Ship-To addresses, quantities, configurations, etc., can have serious repercussions on the deployment
- Change Management is critical. If changes in the schedule are made, related changes in the production ordering must be accounted for. The typical mode of failure here is informal direction from the customer to change a site schedule, but

formal documentation and propagation of that change is not made and the material orders are placed per the original plan

Monitoring and Control

Once the initial material orders are placed, the PM enters the monitoring and control portions of the project. At this point, the PM must rely on feedback signals from the various material sources to identify if the planned schedules are being made. It is this set of feedback signals that the remainder of this paper will focus on. Due to the complex nature of the material tracking data and the wide variety of external sources of interference, knowing exactly what gear is where, and estimating when it will arrive at its next destination, can be surprisingly complex.

Noise in the feedback signals

In our era of web-based, real time, GPS enabled delivery tracking; it may seem to a consumer electronics customer that MS-MS material management would be straight forward and easily managed. In real-world commercial execution, however, the supply chain complexity is orders of magnitude larger than tracking individual parcel shipments from Amazon.com or other online retailers. A variety of fluctuations and data dependencies can conspire to derail a well established plan. In most cases, the automated freight tracking information provided by freight carriers is reliable and consistent, particularly for small quantity orders. As quantities increase, changes in freight management and variations in manufacturing processes will insert increasing amounts of errors and gaps into the material tracking data. The following is a list of deficiencies and defects that have had detrimental effects on actual deployment operations for personal computers, servers, and related peripherals, based on the author's experience

- OEM breaks a bulk order of 1000 units into multiple smaller internal orders as needed to smooth material flow through OEM factories. One or more of those orders fails to be introduced into the manufacturing process, while others proceed normally. Failure to identify that delay places one or multiple sites at schedule risk
- An OEM production order must be cancelled and restarted due to scheduling/production issues. The original order number is replaced with a new order number, which was not part of the original Order Tracking data set and is not monitored by the PM
- Multiple parcel packages are consolidated by a freight carrier into larger, bulk-freight pallets. The original parcel tracking numbers are replaced by a single Heavy-Air waybill number by the carrier, but the PM continues to look for progress on the parcel packages, losing visibility to the actual freight movements
- Supply parts necessary to OEM operations are tracked from the source to the OEM, but visibility is lost after they are delivered. Variations in the OEM processes lead to mis-allocation of those parts to a different customer, but the PM does not have direct visibility to that transfer. He is not aware of an issue until the OEM orders fall behind the build schedule
- Critical but simple peripheral components (cables, shipping crates, notebook accessories) are not included automatically with the primary device (Server, Notebook, etc) when ordered in bulk, and must be sourced individually. Lack of understanding of this results in those components not being ordered or available for the sites

- Data feeds from various OEM's, vendors, warehouse partners and freight carriers do not update at the same frequency, opening gaps in tracking information when material is expected to move from one partner to another
- Delivery made, but Proof of Delivery paperwork (POD) is not accurately recorded (including customer signature) by the carrier and material is not properly controlled at the customer site. This has resulted in disputes where freight is unaccounted for, the carrier claims delivery, but customer does not accept responsibility without signed POD. Dispute resolution will add delays and further impact timeline integrity as well as cash flow and overall margin.

Perturbations caused by Operations

In addition to the data gaps listed above, the PM and other operations personnel will tend to take actions that inject additional errors into the material tracking data stream. For instance, in response to a need for a change to the deployment schedule for one or more sites, a PM might re-direct freight from one site to another. If this is done manually by working directly with freight carriers, the original "Ship-to" destination on the OEM orders, as recorded in the OEM Order Management databases, will no longer be accurate. The tracking data provided by the automated toolsets from the OEM may not reflect that change, however, and the OEM data becomes outdated and inaccurate. It is up to the PM, then, to manually track that change and validate that it is executed accurately. That kind or operator-inserted variance, along with the others listed below, will add to the inaccuracies in the various freight tracking data streams and compound the problem that a PM faces in using the tracking/status data as a valid feedback mechanism to control a deployment project. Below are additional examples of potential Operator Inserted variances to the supply chain material tracking signals.

- Freight is manually directed from Site A to Site B outside of the OEM order management process, making the OEM provided shipment data outdated and inaccurate
- Manual changes in the ship method (ground to air, bulk to parcel, upgrade to Next day delivery, etc) may not be reflected in the OEM or carrier tracking data since it was not an attribute of the original order, making ETA and schedule planning difficult
- Poor site planning/notification, particularly for small sites like Data.com, may result in delivery refusals at the site. This has happened when sites are not open for deliveries at specific times, or when deliveries are handled by site personnel unaware of the schedule and unwilling to accept responsibility for high value material by signing for the delivery from the carrier. This results in ripples and disruptions throughout the supply chain and deployment schedule as material must be replaced, re-routed, or diverted from other sites to maintain timeline integrity
- Poor site planning results in OEM orders that do not match in qty the exact amounts required at a specific site. Orders must be de-constructed while in transit to distribute correct quantities per site, making the original OEM order data and shipment data inaccurate. New quantities and destinations must be tracked manually, outside of the standard data streams
- Freight is delivered complete to a site, but with excess quantities. Material must be picked back up and re-deployed to a different site, under new freight tracking information. OEM data will show a complete delivery, but the customer sees an

incomplete site deployment, giving rise to disputes in billing and collections on a site-by-site basis

- Devices are not operable after delivery to a site, known as Dead on Arrival, or DOA. Replacement material must be ordered and delivered, and original material returned for credit, giving rise to multiple additional freight movements that are critical to both timeline management and proper invoicing/collections.

PROBLEM SUMMARY

In the scenarios above, an OEM Project Manager is tasked with planning and executing a complex sequence of inter-dependant material movements and manufacturing activities in order to enable infrastructure improvements for a given customer (Data.com). Developing and executing a multi-site technology refresh is a challenging endeavor that requires, among other things, a very accurate picture of material movements and manufacturing cycle times. The data that a PM has available will come from a variety of sources that have inherent latency, accuracy, and integrity problems. Additionally, adjustments in the customer, supplier, and intermediary partner schedules are inevitable and add a multitude of potential gaps and inaccuracies into the already volatile material tracking data streams. That material tracking and OEM order status data serves as the primary feedback mechanism that a PM uses to control the project execution, maintain or reset stakeholder expectations, and limit cost and schedule variances. Knowing that the feedback mechanism is volatile and potentially inaccurate, it is a valuable exercise to identify methodologies that will limit the project risk created by data variances, empower a PM to better execute project changes, and reduce the overall exposure that a customer has to perturbations in the current global Information Technology supply chains.

In the following sections, I will more deeply explore the sources, impacts, and mitigation options for data inconsistencies that are inherent in current supply chain infrastructures. I will also develop approaches that allow a project manager to make better, controlled changes to project execution while still maintaining control and visibility to ongoing material movements.

In the end, I will present a structured process that enables a PM to prepare for a MS-MS deployment and leverage available data sources to effectively monitor and control the planned execution. The process I present requires a detailed approach to data management and data mining in order to maintain control over a deployment timeline. To support the data management requirements, I will also present a simple, spreadsheet based approach to monitoring material movements. This is a discussion on the process, however, and not a specific data tool. The results I describe here are related to a spreadsheet-based approach that I have developed in order to support the various elements of the MS-MS deployment executions. Other, more robust and tools-based solutions are available, but this approach puts both data management and project management in direct control of the PM, without relying on specialized, potentially expensive software suites or an in-depth technical knowledge of database architectures and query methodologies.

Chapter 3: Insight from the Current Literature

The complexities of the Case Model described above, as well as the real world engagements that it is drawn from, open the possibility that existing literature across a wide breadth of commercial and engineering disciplines may contribute to a better solution to the problems faced by the OEM PM. This chapter describes research into a variety of disciplines, and how they each contribute to the development of a solution

SUPPLY CHAIN MANAGEMENT

Extensive studies and literature are available on various aspects of supply chain management. Amaral and team (Amaral, et al, 2006) describe the impacts, both positive and negative, of outsourcing of electronics manufacturing from OEM's to Contract manufacturers. More recently, Atallah (Atallah, et al, 2011) presented options for better protecting those same outsourcing operations from the unintended issues of cost transparency. More relevant to the material management aspect of the Case Model, Askegar and team (Askegar, 2004) discussed the migration from traditional supply chain management to Demand Driven supply chains where real time demand signals have a direct impact on supply chain operations. Similar demand signal monitoring is incorporated later in this paper, but most of the supply chain discussions present multi-source material management at a macro-level view, exploring options for firms to optimize their supply chains at an aggregate level, but not exploring in a meaningful way the tracking and management of material for a single customer engagement. Sethi (2007), Raghunathan (2009), and Evrard-Samuel (2008) present macro level views on various aspects of supply chain optimization for service level attainment, Cost-optimized locations, and demand planning collaboration that have concepts relevant to the discussion here, but they did not offer tactical, decision making tools that are practical to the OEM PM engaged in MS-MS deployments. Gaukler (2008), however, did present an analysis that may be adapted, in concept, to the focus of this paper. His effort focused on leveraging Order Status information, within the supply chain, to make a critical decision on leveraging fast-tracked emergency stocking orders to smooth out fluctuations present in current material replenishment policies. The tenets of that analysis may help a PM understand when material tracking information is showing that a violation in the deployment schedule is possible.

One interesting approach to improving supply chain signal integrity comes in the form of FIT, or Forwarder Independent Tracking (Karkkainen, et al, 2004). This approach involves leveraging touch-points and scan-points throughout the supply and logistics channels to provide uniform location update messages as material moves through the channels. This approach allows for real time tracking of material across heterogeneous networks of suppliers, OEM's, resellers, and freight carriers. Though the system is not widely adopted, the concept helps to solve for some of the very data integrity issues that affect a PM in managing MS-MS Deployments today. Specifically, as material moves throughout the supply chain today, transfers from vendors to integrators to resellers happen across disparate freight carriers and the tracking information is not integrated well enough to provide an end to end picture of the material movements. In the MS-MS process described below, these gaps are addressed by layering data from different sources onto the baseline tracking information available to an OEM. A far better solution would incorporate real-time tracking of material movements, independent of the carrier or vendor in immediate possession of the equipment.

DATA MANAGEMENT

A primary component of the MS-MS deployment problem is the limited ability to track and control material movements in a dynamic environment with both inherent and operationally imposed inconsistencies and inaccuracies in the data streams. Extensive research and literature exist in the fields of data management and database administration, but a primary goal of my effort here is to develop a practical approach to managing complex material movements and I did not explore the nuances of complex data mining algorithms. I did, however, investigate some industrial applications of material data management that provided insight.

Efforts to improve the accuracy of RFID data (Tu, et al, 2011) used for supply chain operations have some relevance to the MS-MS problem. In those cases, the RFID data stream has inconsistencies that are similar to the gaps in supply chain information presented to a PM today leveraging more conventional tracking information. That research focused on data errors similar to those present in the Case Model, but the solutions proposed were centered primarily on correcting data collection issue, not in reconciling the data once collected. Fan (2011) presents algorithms for automatically identifying Conditional Functional Dependencies maintained within a large dataset. Applications of those algorithms may provide value in systematically identifying inconsistencies in MS-MS data, but the concepts and practical implementation of their techniques are well beyond the skillset and scope of the OEM PM envisioned here.

The construction industry provides several parallel efforts that may be of value in solving for MS-MS complexities as well. One challenge stems from tracking the multitudes of material movements present on a large scale construction project where delays can be more impactful than the issues encountered in MS-MS deployments. Currently, a wide variety of sensors exist in that industry to provide real-time material tracking, including RFID, GPS, Ultrasonic tags, barcode scanning, and an array of RF tagging mechanisms. The variety of sensors gives rise to a need for consolidating the different signal sources into a coherent picture of material movements. Research is available (Razavi, et al, 2010) on potential methods for fusing that multi-sensor data into a consistent picture. Similar to MS-MS deployment issues, that multisensor data fusion involves compensating for inconsistencies in the available data. The techniques are geared more towards an application development for specific use in that field, but some of the concepts related to dealing with "fuzzy" inferences to quantify data reliability can find applications in the efforts presented here.

PROJECT MANAGEMENT

Also rooted in the construction industry, the concepts in the Last Planner System of Project Management (Ballard, 2000) provide different options for the OEM PM to leverage supply chain data to drive a successful MS-MS deployment execution. Key concepts include the notion that "traditional project control presumes after-the-fact variance detection" is not very functional as a control mechanism and that a better approach is to cause the events to conform to a plan through specific actions. He draws a parallel between construction planning and manufacturing operations, noting that traditional PM goals “detect negative variances from target so corrective action can be taken” while manufacturing process controls “Cause events to conform to plan”. To that end, the idea behind Last Planner control is to meet timeline objectives by controlling the flow of information and materials, not course correcting by “trying harder” or adding people. Karkkainen (2006) fused the FIT material tracking mechanisms with the Last Planner approach to project management to develop a methodology for leveraging real-time material tracking information to maximize the efficiency in executions of a construction project. This presentation shares many common features with the MS-MS issues described in the Case Model, and elements can be applied to the solution developed here.

Chapter 4: Dissecting the Supply Chain Signals

Typical Signal Hierarchies

At its basic level, the supply chain execution of a MS-MS deployment involves the interpretation and response to demand signals from a customer, much the same way that factory operations, global material forecasting, and large scale Supply Chain designs do (Lee, 2004). For a MS-MS deployment, the signal-response relationship is scaled down and focused to a specific set of needs for a specific customer. In planning the execution, though, it is vital to define what the demand signals from the customer will look like, how they should be interpreted, what the customer expectations are (and what they should be), and how those signals translate throughout the supply chain. The initiating customer signals in the hierarchy described below are typical to many commercial and government purchasing agencies, based on the author's direct experiences. The supply chain elements discussed here are based on the Dell Inc. infrastructure.

- Pre-positioning: Based on planning activities, suppliers involved in the deployment may choose to pre-position materials in advance of the actual execution start. This is typically done to minimize lead times and reduce schedule risks once the deployment begins. This pre-positioning is done by the suppliers at their own cost, based on good faith negotiations with the customer and/or other vendors in the supply chain. Signaling activities to start this positioning are usually informal and do not follow the typical order/fulfillment mechanisms of an actual purchase. Pre-positioning is done based on scheduling discussions during project planning

- Customer Signals: Customer initiates the execution with Purchase Orders submitted to the primary vendor. That vendor (the Prime) owns responsibility for multi-source procurement of all materials included in the execution. The Purchase Orders can be the over-arching contract mechanism that commits payment to the vendors and empowers them to begin to consume resources, materials, and debt to downstream suppliers. The customer may provide a variety of purchase orders, depending on their internal purchasing and accounting requirements, to support a single MS-MS deployment effort
- OEM Signals: The Prime or OEM translates the Customer PO's into a variety of supply chain signals that begin manufacturing and shipping activities. In the Data.com example, we will assume the Prime is also the main OEM that will be manufacturing the major IT components (Servers, PC's). In this case, the following signals are generated by the OEM
    - Manufacturing orders: production orders created by the OEM to support the customer PO. These orders go to the OEM production facilities to initiate the build of OEM components. A multitude of different production orders, each with its own unique identifier, may be needed to support the quantity/configurations defined in the customer POs
    - Vendor Orders: The OEM will generate orders to vendors to procure components that are called for by the customer PO's, but not part of the OEM product portfolio. In the Case Model, these vendor provided options may include Non-OEM brand specialty monitors, network switchgear, battery-

backup units (uninterruptable power supplies), printers, specialty cables, notebook carrybags, and a variety of peripheral items

- Supplier stocking orders: To support manufacturing demands, the OEM production facilities may need to place stocking orders for sub-assembly and component parts in order to complete the OEM builds. These orders bring component materials into the OEM manufacturing facilities through the OEM Supply Chain networks. If planning and pre-positioning were successfully leveraged, these stocking orders will be part of the normal OEM processes and will not add to manufacturing leadtimes or give rise to any production delays. Note: These orders are typically not visible to the PM or the customer

- Vendor Signals: Upon receipt of vendor orders from the Prime, vendors may need to leverage their own supply chains to deliver products. In some cases, the vendors may be distributors of multiple product lines from a variety of manufacturers, or the Vendor may be an OEM of their own branded products. In either case, the Prime will rely on the Vendors to provide feedback signals on the status of the vendor orders. Like OEM supplier stocking orders, however, pre-positioning can be used to limit risk and cycle times, and the Prime will typically not have visibility to subsequent orders placed by the Vendor down their individual supply chains.

Signals defined for the Case Model

In the planning phases, as it relates to these supply chain signals, is it important for the PM to establish the standards and set expectations around what the demand signals will look like, including the form, scope, and content for customer PO's, and the expected translation by the Prime of the Customer PO's into OEM/Vendor orders. In our case model, those definitions can look like this:

Customer PO's: 3 separate PO's that will cover Client hardware (DT/NB and peripherals), Enterprise hardware (servers, storage, networking) and Installation Services (deployment technicians provided by the OEM at each site). The Client/Enterprise PO's will include all related Peripherals. The Services PO will be one Bulk purchase for the entire deployment activity, to be invoiced incrementally as each site is completed.

Manufacturing Orders: Client system orders will have a Maximum of 24 units per manufacturing order to facilitate factory planning, with Desktop and Notebook units on separate orders. Each customer site will be supported by several Manufacturing orders, with the orders set to ship directly to their designated site ("Ship-To" address on each order is the customer site delivery address). Enterprise orders will be small quantities and will only have one manufacturing order per site for all Servers, and a separate order for Storage units.

Vendor Orders: Non OEM-branded client peripherals, Networking products, and specialty Non-OEM components will be on separate vendor orders, separated by customer site, with no quantity limits per Vendor Order. There will be different Vendor orders per site, based on the brands and products being ordered.

These planning elements are a small subset of the overall execution plan, but are instrumental in how the subsequent order status information can be used to control the project once it begins to execute.

Chapter 5: Managing the Multi-Source, Multi-Site Deployment Data

The Target

Once a MS-MS deployment begins, like other Project Management Efforts, the PM will work to deliver results in a very dynamic environment <PMBOK Reference>. Changes in requirements, delays in site execution, material delays, and a multitude of additional challenges will conspire to drive the execution outside of plan. In that environment, the PM will need to extract useful information from the variety of available data sources to regularly determine the next actions to be taken. The key elements of the MS-MS process described here are the tools and techniques that empower a PM to identify potential issues early and to adapt to changing requirement effectively. To that end, the process centers on developing two key information dashboards:

1. **The Status Snapshot:** A real time picture of progress, risks, and critical issues
2. **The Status Timeline:** A deeper view of progress than the snapshot, the timeline information helps to identify trends, provide reporting, and troubleshoot failures

The Snapshot and the Timeline are procedural tools that can take different forms in different environments. For this paper, however, I will present a simple, spreadsheet approach to aggregating multiple sources of data over time to develop a working Snapshot and Timeline view of the case-model MS-MS Deployment. In order to develop a working, flexible, capable aggregation of supply chain data into the Snapshot and Timeline views, the PM needs to first establish the hierarchy of information that is available, along with a data-driven view of what the customer requires in a successful deployment. Below, I present 3 primary phases needed in developing a workable data aggregation plan

1. Site Plan: Establish the baseline plan for material requirements and individual sites throughout the deployment cycle
2. Data Plan: Based on the Site Plan, identify the data streams that will be available to monitor all relevant material movements. Leverage those data streams to define how material planning, tracking, and monitoring will be conducted
3. Monitoring Plan: Define the specific indicators within the Data Plan that will be used to identify risks, communicate progress, and measure success

Each of these key steps is described in detail below

Site Plan

At a high level, the site plan will need to identify the physical sites being deployed to, the material requirements at each site, and the timeline for delivery by site. The Site Plan is primarily dependant on customer requirements and technician capacity/availability at each site. For this discussion, as has been typical in my experience as well, the Site Plan is developed by the customer and identifies high-level material requirements only (number of PC's, Servers, etc). Additional details related to special delivery requirements, hours of operation, detailed material requirements, etc., must be filled in by the OEM PM. Table 3 lists the key elements to consider in developing the detailed site plan, based on the author's prior experiences in managing deployments.

1.	How will each site be referred to by name?
2.	Define the hierarchy of buildings to sites to campuses ensure consistent reference in all communications
3.	Define detailed product requirements per site
4.	Define the deployment timeline in terms of sites and target delivery dates. Identify if multiple deliveries will be required at any sites
5.	Determine delivery windows around the target delivery dates at each site.
6.	Determine freight transportation methods to be used and typical transit times to each site

Table 2: Site Plan Development

There are innumerable additional variables that may be included in the site plan development, but these key elements will feed into the development of the Snapshot and Timeline management views for monitoring and measuring that I will present later. Of particular note, however, are the site-specific delivery requirements that must be documented and validated. These requirements may include specialized delivery vehicles, constrained dock-door times, special palletization and handling requirements, security screening requirements, and a host of other logistical details that can delay final material delivery even if all required products are made available to the sites at the prescribed schedule. For the purposes of this discussion, however, I will focus on methodologies needed to ensure adherence to the delivery schedule only, and not on accounting for the specific site requirements.

For the Case Model, Figure 1 shows a Site Plan that meets the basic requirements for the MS-MS management process. In this case, each site is defined by its unique delivery address and basic information including Target Delivery Date (TDD) and specific product requirements are documented. Quite a bit of additional data may be available, including details of each site, product technical requirements, Delivery windows, etc. A goal in developing the Site Plan, though, should be to keep the basic plan as simple and free of extraneous data as possible. This enables consistent communication of key information without cluttering the information with details that can be referenced elsewhere. Each field of data added to the site plan should provide enough detail to be unique in the plan, without inserting redundant information. Adding the full shipping address for each site, for instance, could add multiple fields of data without any unique information. To that end, the shipping address used in this Site Plan could be simplified to be only a site name ("Site 1", "Site 2", etc) to further streamline communications, if all parties involved are familiar and comfortable with the nomenclature. In practical execution, customer sites tend to be referred to by internal corporate standards. The buildings at the Dell Corporate headquarters in Round Rock are numbered, for instance, and any site operations typically refer to the campus and building number (Round Rock 1, 5, 8, etc). Care must be taken in establishing common terms to reference each site, however, to ensure that no ambiguity exists in the exact site being scheduled or reported against. As an example, using the street name as the site name, without the street number, will cause confusion and failure during the deployment if the customer has multiple buildings/sites on the same street.

Additional details tied to each element of the site plan (detailed shipping addresses, product technical information, etc) can be linked to the Site Plan for reference if those details don't help to uniquely identify a site. For practical purposes, as I will show later, the site names should be short enough to be uniquely identified in a single data field. This facilitates data management later in the execution and helps to reduce errors in communication and planning

Site	Customer PO #	Target On-Site date	QTY	Product Line
Site 1 Street Address_1	PO-Client	7/24	15	Notebook
Site 1 Street Address_1	PO-enterprise	7/24	2	Server Peripherals
Site 1 Street Address_1	PO-enterprise	7/24	2	Web Server
Site 10 Street Address_1	PO-Client	8/8	10	Desktop
Site 10 Street Address_1	PO-enterprise	8/8	1	Network Switch
Site 10 Street Address_1	PO-enterprise	8/8	1	Server Peripherals
Site 10 Street Address_1	PO-enterprise	8/8	1	Web Server
Site 11 Street Address_1	PO-enterprise	7/25	1	Network Switch
Site 11 Street Address_1	PO-Client	7/25	50	Notebook
Site 11 Street Address_1	PO-enterprise	7/25	3	Server Peripherals
Site 11 Street Address_1	PO-enterprise	7/25	3	Web Server
Site 12 Street Address_1	PO-Client	7/23	5	Desktop
Site 12 Street Address_1	PO-enterprise	7/23	1	Network Switch
Site 12 Street Address_1	PO-enterprise	7/23	1	Server Peripherals
Site 12 Street Address_1	PO-enterprise	7/23	2	Server Peripherals
Site 12 Street Address_1	PO-enterprise	7/23	2	Web Server
Site 13 Street Address_1	PO-Client	7/29	8	Desktop
Site 13 Street Address_1	PO-enterprise	7/29	1	Network Switch
Site 13 Street Address_1	PO-enterprise	7/29	1	Server Peripherals
Site 13 Street Address_1	PO-enterprise	7/29	1	Web Server
Site 14 Street Address_1	PO-Client	7/25	12	Notebook
Site 14 Street Address_1	PO-enterprise	7/25	3	Server Peripherals
Site 14 Street Address_1	PO-enterprise	7/25	3	Web Server
Site 15 Street Address_1	PO-Client	7/24	10	Notebook
Site 16 Street Address_1	PO-enterprise	7/30	1	Server Peripherals
Site 17 Street Address_1	PO-Client	7/10	22	Notebook
Site 17 Street Address_1	PO-enterprise	7/10	1	Web Server
Site 18 Street Address_1	PO-enterprise	8/12	1	Network Switch
Site 18 Street Address_1	PO-Client	8/12	3	Workstation
Site 19 Street Address_1	PO-enterprise	7/21	2	Uninterruptable Power Supply
Site 19 Street Address_1	PO-Client	7/21	1	Workstation

Figure 1: Case Model Site Plan Example

The Site Plan also dictates how the supply chain signals will be interpreted and monitored. The Snapshot and Timeline views of the supply chain data will be developed by comparing real-time production and logistics information to the site plan and identifying gaps and risks for hitting the plan. To accomplish this in a predictable, repeatable manner, the Site Plan needs to be matched to the available data streams that will be used to monitor project execution. To accomplish this matching, a detailed Data Plan needs to be developed.

Data Plan

The Data Plan connects the real-world site plan to the various data streams that are available to monitor and manage the execution. In developing this plan, the PM will define how the raw supply chain signals will be interpreted to match the Site Plan. To develop that interpretation, the PM will need to be aware, prior to project execution, what the supply chain data signals will look like, what frequency they will be received, and what details will be contained within. Using the available data streams, then, the PM will need to define what information will be used to determine delivery status, risk, variation, and error identification.

In Dell Inc, there are a multitude of data reporting mechanisms available internally to employees and project managers. To develop a sample data plan here, I selected a standard Order Status Report (OSR) that provides a variety or information related to each manufacturing order placed. Data related to vendor orders is also presented, but with more limited granularity. The Standard OSR contains 32 data fields of production, customer, product, and tracking information. In establishing the data plan, the primary goal is to select the standard data feeds that will be used by the PM and build a monitor and control structure around that consistent data. I could select any of a number of other standard reports, but the data plan is based on selecting one recurring stream of information and sticking with it throughout the execution. Changing the source data during the execution can insert additional error and uncertainty into the management of the execution. Table 4 lists the data fields available in the standard Order Status Report. The OSR pulls information from a variety of internal Dell order management and production tools and consolidates the data into a single recurring report.

Link#	Product Line
Customer #	Product
Customer PO #	Ship Method
Dell Order #	Carrier
Invoice #	Waybill
Order Type	Delivery Date
Status	Delivery Signature
Order Entry Date	Ship Company
In Production Date	Ship First Name
Current Estimated Ship Date	Ship Last Name
Est Ship Date Revision Count	Ship Address 1
Actual Ship Date	Ship Address 2
Invoice Date	Ship City
Order Qty	Ship State
	Ship Zip

Table 3: Example Order Status Report Data Fields

For the purposes of this paper, the OSR serves as the baseline data source for developing the process for managing MS-MS deployments. Any other recurring data sources would also be allowable, provided they deliver the data elements necessary to meet the monitoring and measuring requirements.

Here, the OSR will provide the primary data stream. The purpose of developing the Data Plan is to define how the OSR (or any other recurring data stream) will be used to translate status data into information useful in managing the MS-MS deployment. I mentioned above that a Status Snapshot and a Status Timeline are the key tools in monitoring the project progression. To build out the data plan, the PM will need to identify how the available data streams will be used to develop those two views of project progress. To that end, several key parameters must also be defined in order to maintain consistent communications and messaging throughout the engagement. Those control parameters are described in Table 5

Control Parameter		Attribute Name
1.	What data element uniquely identifies a Site?	Site
2.	What data elements uniquely identify the product being delivered?	Product
3.	How is the Estimated Delivery Date for any order determined?	EDD
4.	How many days prior to the Site Plan Target Delivery Date is a delivery acceptable? (may be 0)	Early_TDD
5.	How many days after the Site Plan Target Delivery Date is a delivery acceptable? (may be 0)	Late_TDD
6.	How will an order be determined to be at risk of missing it's TDD?	TDD-At-Risk
7.	Some MFG and VENDOR orders may be cancelled during the process, how is a valid order differentiated from a cancelled order	Live?
8.	What data indicates a delivery has been completed?	POD
9.	What are available shipping methods and transit times, and how are they identified in the data stream?	Ship_Method

Table 4: Data Plan Control Parameters

For the Case Model, the Control Parameters are defined in Table 6, basedon the specific data fields available in the OSR.

Case Model Definitions - Control Parameters		OSR Field
1.	Each Site is uniquely defined by the Address_1 field	Address_1
2.	Based on the material being ordered, the Product_Line field uniquely identifies each component. Note: the "Product" field has a more detailed technical description of the products and would work as well, but the added details do not add to the uniqueness of the data in this specific case model	Product Line
3.	Current_Estimated_Ship_Date will be used to calculate all related delivery timeline estimates	Current Estimated Ship Date
4.	Status is used to identify MFG order progress through the OEM process	Status
5.	Delivery_date indicates an order has been delivered	Delivery Date

Table 5: Case Model Control Parameters

To support the control parameters using the data fields available in the OSR, specific calculations must be performed on each order in each recurring OSR. Those calculations can be seen as a translation between the raw data and information that a PM will find useful. As part of the Data Plan, I'll refer to this collection of algorithms as the Translator. The Data Plan requires a Translator to convert the raw data into useful and customer friendly information. For the case model, the Translator includes the algorithms in Table 6:

Translator Algorithms and Parameters	
1.	Ship Method Transit Time: 1, 2, or 5 days of transit time, depending on Ship Method assigned to each order in the OSR
2.	EDD = ESD (from OSR) + Ship Method transit time
3.	TDD is a fixed value defined in the site plan
4.	Allowable_Days_Late and Allowable_Days_Early are constant values defined in coordination with the customer
5.	Earliest allowable delivery = TDD – Allowable Days early
6.	Latest allowable delivery = TDD + Allowable Days Late
7.	Order is flagged as TDD_At_Risk-Early if: EDD < Earliest allowable delivery
8.	Order is flagged as TDD_At_Risk-Late if : EDD > Latest allowable delivery
9.	Order health is defined by the maximum number of days a MFG Order should stay in "In Production" (or IP) Status – This is defined by the PM based on experience and input from supply chain managers - Attribute is "Long IP"
10	For Case model, Order is flagged as Unhealthy when "Date of Snapshot" - "In Production Date" > "Long IP"
11	Order is flagged as “Live” if OSR_Status <> “Cancelled”
12	Order is flagged as Shipped when OSR_Actual_Ship_Date <> Blanks (note: this is a nuance of the OSR, a similar flag would apply with other supply chain data)

Table 6: Case Model Data Translator

As noted earlier, part of the challenge in managing a MS-MS deployment is potential inconsistencies and incongruities in the supply chain signals. As a typical example, the Ship-Method field can be particularly sensitive. As shown above, the ship method plays a direct role in estimating material delivery dates (see EDD, TDD_At_ Risk). At the same time, changing the ship method when an order is determined to be at risk of missing its TDD is a beneficial capability available to a PM. Unfortunately, depending on the data streams involved, upgrading the shipping method after an order has progressed through the initial stages of manufacturing can be challenging and very manual, sometimes done directly with the freight carrier and bypassing the ODM/Vendor processes. In that case, the material will actually have a shorter transit time, based on the upgraded ship method, but the Supply Chain data (the OSR in the case model) will still reflect the original information tied to the initial order. In practical terms, the order will still be flagged as "As Risk", based on the OSR and the Translator algorithms above, but may actually be on track as a result of the reduced transit time. The PM will need to document those kinds of manual changes, and the Data Plan and Monitoring plans should have a mechanism to override supply chain signals that are known to be incorrect and identify At-risk activities based only on the most accurate information available. This methodology is a "Manual Input" mechanism that enables a PM to maximize the data stream accuracy by using all available sources, even if they are not embedded in the standard supply chain signals

For the Case Model, the Manual Input process allows the PM to insert manual data for individual MFG or Vendor Orders. The data can include changes to the Ship Method, the Estimated Ship Date, Transit Time, or the destination Site (Address_1 field in OSR). Specifically, for the Case Model data plan, I created a table for Manual Updates into the MS-MS tracking workbook. Any data placed into the Manual Update table will override data presented for those same fields in the OSR.

Data Plan Summary

The Data Plan is the key element in leveraging Supply Chain data to effectively manage a complex deployment. Construction of the plan enables effective and efficient translation of detailed data elements into information useful in decision making and project management. To summarize, the key considerations in developing the Data Plan include:

1. Identify the recurring source data that will be available throughout the deployment and understand the individual data elements contained within
2. List the specific data elements that the PM will need to monitor and control in order to meet the deployment objectives **(Control Parameters)**
3. Define the algorithms that will be used to translate the Control Parameters into real-world information that will aid the PM in monitoring and Decision Making **(Translator)**
4. Identify the data elements that can be changed manually, but may not be accurately reporting in the supply chain data. Provide a mechanism to allow the PM to override the supply chain data with more accurate information **(Manual Input Method)**

Monitoring Plan

With the Site Plan and Data Plan Established, a Monitoring Plan can be defined to enable monitoring, control, and communications on the deployment execution. A key part of the monitoring plan is the development of the Snapshot and Timeline views of the aggregated supply chain signals.

For the MS-MS deployment, key objectives in designing the Monitoring Plan are described in Table 7

Monitoring Plan Objectives	
1.	Identify orders At Risk for meeting their site TDD
2.	Identify shortages in material procurement for individual sites, as compared to the Site Plan
3.	Identify Errors in product configurations for individual sites, as compared to the Site Plan
4.	Identify emergent supply chain gaps/errors before they impact the project timeline
5.	Accurately report on the deployment progress
6.	Account for changes in the site plan or delivery plan while maintaining overall plan integrity
7.	Empower the PM to take action to resolve deficiencies that may impact the deployment execution

Table 7: Monitoring Plan Objectives

These objectives lead to the development of the Status Snapshot and the Status Timeline dashboards, based on the data available from the data plan. As stated previously, a primary objective of this paper is to develop a methodology for managing MS-MS deployments that is accessible to OEM PM's without the need for advanced databasing skills, customized application development or purchase, or complex macro execution within a spreadsheet. The data views described below are taken from a Microsoft Excel workbook built to execute the Data Plan defined above. For reference, Appendix B details the architecture in that workbook. It was developed for ease of use by a PM, but was strictly limited to standard cell-reference functions, pivot tables, and other Excel features.

Status Snapshot

The Status Snapshot is a mechanism to provide a PM with a simple view to the status of the deployment execution based on the most current supply chain information available. As noted above, the Monitoring Plan includes several different objectives for quality control and communication, each of which involves a slightly different view of the status of a deployment. For our Case Model, the Status Snapshot needs to identify clearly the following attributes

Snapshot Attribute	
1.	QTY of each product required by each site, per the site plan
2.	QTY of each product on order for each site (Live Orders Only)
3.	Health of OEM MFG Orders
4.	Orders at Risk for missing their TDD
5.	Have any orders been cancelled?
6.	Qty of material left to Ship
7.	Qty of material that has already shipped
8.	Qty of Material on Live Orders compared to QTY required by the Site Plan
9.	Qty of Material not yet shipped, compared to QTY required by Site Plan

Table 8 Status Snapshot Attributes

Figure 2 shows a view of the Status Snapshot for the Case Model deployment that displays that QTY of each product type, for each site, based only on the Site Plan (attribute 1 in Table 8). Discrete product types are shown in columns, with quantities for each site show in each row. Note that Sites, Products, and TDD's are presented in one view, easily consumed by the PM and other stakeholders (see Appendix B for details of the Status Snapshot calculations and display).

Plan Qty

Sum of Display Amount	Co							
Site	Workstation	Uninterruptable Power Supply	Server Peripherals	Desktop	Notebook	Network Switch	Web Server	Grand Total
cancelled								
Site 13 Street Address_1				0		0		0
Site 18 Street Address_1	0							0
7/2/2011								
Site 20 Street Address_1					10			10
7/8/2011								
Site 22 Street Address_1					8			8
7/10/2011								
Site 17 Street Address_1					22		1	23
7/17/2011								
Site 9 Street Address_1			3	1			3	7
7/21/2011								
Site 19 Street Address_1	1	2						3
7/22/2011								
Site 2 Street Address_1	2		1					3
Site 21 Street Address_1				5		1		6
7/23/2011								
Site 3 Street Address_1			1					1
Site 12 Street Address_1			3	5		1	2	11
7/24/2011								
Site 15 Street Address_1					10			10
Site 1 Street Address_1			2		15		2	19

Figure 2: Status Snapshot - Plan QTY View

Functionally, the Status Snapshot in this example is an Excel Pivot Table of the underlying OSR data, converted into the appropriate values based on the Translator Calculations outlined in Table 6. Using a standard pivot table provides the added flexibility allowing the OEM PM to drill down into the individual site plan information that is displayed in each view.

Attribute 2 of Table 8 calls for a Snapshot view of the Live Orders related to the deployment. Figure 3 shows that view, based on one day's OSR. This view shows all of the Live Orders associated with the deployment. As noted in the Data Plan, Live Orders are any order in any production phases that have not been cancelled.

Live Qty

Sum of Display Amount

Site	Workstation	Uninterruptable Power Supply	Server Peripherals	Desktop	Notebook	Network Switch	Web Server	Grand Total
cancelled								
Site 13 Street Address_1				0		0		0
Site 18 Street Address_1	0							0
7/2/2011								
Site 20 Street Address_1					10			10
7/8/2011								
Site 22 Street Address_1					1			1
7/10/2011								
Site 17 Street Address_1					1		1	2
7/17/2011								
Site 9 Street Address_1			0	1			0	1
7/21/2011								
Site 19 Street Address_1	1	2						3
7/22/2011								
Site 2 Street Address_1	2		1					3
Site 21 Street Address_1				5		5		10
7/23/2011								
Site 3 Street Address_1			1					1
Site 12 Street Address_1			1	1		1	0	3
7/24/2011								
Site 15 Street Address_1					1			1
Site 1 Street Address_1			0		1		0	1
7/25/2011								

Figure 3: Status Snapshot - Live Order View

The data in this view is rudimentary and is simply a summary of active orders in the supply chain, based on the OSR. Underlying this view is simply the OSR, in a flat file format, a section of which is shown in Figure 4

Customer #	Customer PO #	Dell Order #	Invoice #	Order Type	Status	Order Entry Date	In Production Date	Current Estimated Ship Date
100504440	PO-Client	719254430		Invoices	Invoiced	6/16	6/20	7/18
100504440	PO-enterprise	740127092		Invoices	Invoiced	7/12	7/12	7/18
100504440	PO-enterprise	702965182		Invoices	Invoiced	5/28	5/28	7/27
100504440	PO-Client	714406084		Invoices	Invoiced	6/10	6/11	7/14
100504440	PO-Client	713099310		Invoices	In Production	6/9	6/13	7/22
100504440	PO-Client	713101181		Invoices	Invoiced	6/9	6/13	7/21
100504440	PO-Client	713103476		Invoices	Invoiced	6/9	6/13	7/21
100504440	PO-Client	724371286		Invoices	Cancelled	6/22		7/13
100504440	PO-enterprise	724372029		Invoices	Cancelled	6/22		7/8
100504440	PO-Client	735709540		Invoices	Invoiced	7/6	7/12	7/26
100504440	PO-enterprise	735710431		Invoices	Invoiced	7/6	7/12	7/15
102410529	PO-Client	720739924		Invoices	Invoiced	6/17	6/20	7/19
102410529	PO-enterprise	720443808		Invoices	Invoiced	6/17	6/18	7/7
102410529	PO-Client	720450456		Invoices	Invoiced	6/17	6/20	6/29
102410529	PO-Client	720458913		Invoices	Invoiced	6/17	6/20	6/29
102410529	PO-Client	724451120		Invoices	Invoiced	6/22	6/23	7/5
102410529	PO-Client	725600501		Invoices	Invoiced	6/23	6/24	7/6
102410529	PO-enterprise	725600865		Invoices	Invoiced	6/23	6/24	8/8
102410529	PO-Client	726641249		Invoices	Cancelled	6/24	6/26	7/26
102410529	PO-enterprise	726641603		Invoices	Invoiced	6/24	6/25	8/9
102410529	PO-enterprise	743009669		Invoices	Invoiced	7/14	7/14	7/20
102410529	PO-Client	727093648		Invoices	Invoiced	6/24	6/25	7/8
102410529	PO-enterprise	727093689		Invoices	Invoiced	6/24	6/25	8/9
102410529	PO-Client	731550971		Invoices	Invoiced	6/30	6/30	7/13
102410529	PO-enterprise	731551169		Invoices	Invoiced	6/30	6/30	7/20
102410529	PO-enterprise	731554213		Invoices	Invoiced	6/30	6/30	8/15
102410529	PO-Client	731741281		Invoices	Invoiced	6/30	7/7	7/14
102410529	PO-enterprise	731741703		Invoices	Invoiced	6/30	6/30	8/15

Figure 4: Sample OSR Data

Independently, these views do not offer much value to the PM in monitoring and controlling the project, but the underlying data can be exploited to present the other attributes listed in Table 8 Status Snapshot Attributes above. By using the Translator algorithms described in Table 6, each order in the OSR can be evaluated for TDD Risk, Order Health, Order Status, and timeline/quantity variations against the Site Plan. By including those calculated attributes into the Snapshot, the PM can gain quick, consolidated view to the timeline risk of any product, for any site. Figure 5 shows a Delta-To-Plan (DTP) view of the OSR data, indicating where product quantities for "Live" orders do not match the Site Plan. This is a quick indication to the PM that insufficient material orders have been placed to meet the site plan (or prior Live orders have been cancelled), and action will be needed.

DTP Live

Sum of Display Amount Co

Site	Workstation	Uninterruptable Power Supply	Server Peripherals	Desktop	Notebook	Network Switch	Web Server	Grand Total
cancelled								
Site 13 Street Address_1				0		0		0
Site 18 Street Address_1	0							0
7/2/2011								
Site 20 Street Address_1					0			0
7/8/2011								
Site 22 Street Address_1					-7			-7
7/10/2011								
Site 17 Street Address_1					-21		0	-21
7/17/2011								
Site 9 Street Address_1			-3	0			-3	-6
7/21/2011								
Site 19 Street Address_1	0	0						0
7/22/2011								
Site 2 Street Address_1	0		0					0
Site 21 Street Address_1				0		4		4
7/23/2011								
Site 3 Street Address_1			0					0
Site 12 Street Address_1			-1	-4		0	-2	-7
7/24/2011								
Site 15 Street Address_1					-9			-9
Site 1 Street Address_1			-2		-14		-2	-18
7/25/2011								
Site 14 Street Address_1			-3		-11		-3	-17
Site 11 Street Address_1			-3		-49	0	-3	-55
7/29/2011								

Figure 5: Status Snapshot - Delta to Plan

Figure 6 shows the TDD Risk view of the same, translated data. This gives a clear indication to the PM of the specific sites and products at risk of violating the Site Plan Timeline.

TDD Risk

Sum of Display Amount	C							
Site	Workstation	Uninterruptable Power Supply	Server Peripherals	Desktop	Notebook	Network Switch	Web Server	Grand Total
Site 12 Street Address_1			0	0		0	0	0
⊟ 7/24/2011								
Site 15 Street Address_1					0			0
Site 1 Street Address_1			0		0		0	0
⊟ 7/25/2011								
Site 14 Street Address_1			0		1		0	1
Site 11 Street Address_1			0		0	0	0	0
⊟ 7/29/2011								
Site 13 Street Address_1			0	0		0	0	0
⊟ 7/30/2011								
Site 16 Street Address_1			0					0
⊟ 7/31/2011								
Site 5 Street Address_1	1		0			0	0	1
⊟ 8/1/2011								
Site 7 Street Address_1			0	25		0	0	25
⊟ 8/8/2011								
Site 10 Street Address_1			0	0		0	0	0
⊟ 8/11/2011								
Site 4 Street Address_1			0		0	0	0	0
⊟ 8/12/2011								
Site 18 Street Address_1	0					0		0
Site 6 Street Address_1			0		0		0	0
⊟ 8/18/2011								
Site 8 Street Address_1			0		0	0	0	0
Grand Total	**1**	**0**	**0**	**25**	**1**	**0**	**0**	**27**

Figure 6: Status Snapshot - TDD Risk View

In similar fashion, alternate views of the translated OSR data are available for each of the nine project attributes called out in Table 8 Status Snapshot Attributes. With this snapshot capability, each recurring OSR can be evaluated independently to determine near term and long term risk to the deployment schedule. Changes to the Site Plan, and Manual Updates can also be correlated to any individual OSR to ensure that the most recent, accurate data is available to the PM.

Status Timeline

The Status Snapshot gives an instantaneous picture of the status and risks associated with the MS-MS Deployment. Over time, though, a PM will also be obligated to show progress trends in the execution of a deployment (PMI, 2008). Reporting requirements for a deployment can require recurring updates on completed activities, progress on open items, and root-cause discussions on missed milestones. At the same time, the Snapshot can identify orders that have been cancelled and material quantities that do not meet the Site Plan requirements, but it does give the OEM PM a clear picture in examining what caused a gap in material availability. The Status Timeline allows a long term, historical view of the deployment to be developed in order to address these kinds of requirements. For our Case Model, the Status Timeline needs to identify clearly the attributes shown in Table 9.

	Timeline Attribute
1.	QTY of each product on order for each site, over time
2.	Live Order QTY Delta to Plan, over time
3.	Qty of At Risk orders, over time
4.	Indication of when a Live Order Qty is reduced, indicating an order was cancelled and generally requiring attention

Table 9: Status Timeline Attributes

The Status Timeline is developed by recording the Snapshot values each time an OSR is generated, and time stamping when those values are generated. This is a straightforward process in a spreadsheet format by simply copying the relevant, translated data from the OSR into a static location, and adding additional data when available. This is a manual process, however, and must be executed diligently by the PM in order to build up the overall timeline picture. More sophisticated methods are available through relational databases and fully developed toolsets <cite examples>, but the intention of this paper is to develop a PM owned process that does not rely heavily on complex data management tools. Figure 7 shows the Status Timeline for the Case Model, including trend tracking.

				5-Jul			10-Jul			19-Jul		
		Snapshot date -->										
Site Plan	**Status Timeline**	→		QTY Live In Plan	Net delta to plan	Live @ Risk	QTY Live In Plan	Net delta to plan	Live @ Risk	QTY Live In Plan	Net delta to plan	Live @ Risk
↓			Totals	470	630	10	511	589	11	516	584	2
			Trend	day 0	day 0	10	41	-41	1	5	-5	-9
Site	**Product**	**Qty**										
Site 1 Street Address_1	Desktop	95		0	-95	0	19	-76	0	19	-76	0
Site 1 Street Address_1	Network Switch	75		0	-75	0	0	-75	0	0	-75	0
Site 1 Street Address_1	Notebook	200		107	-93	0	107	-93	0	107	-93	0
Site 1 Street Address_1	Server Peripherals	3		1	-2	0	1	-2	0	1	-2	0
Site 1 Street Address_1	Web Server	2		0	-2	0	0	-2	0	0	-2	0
Site 10 Street Address_1	Desktop	11		1	-10	1	1	-10	1	1	-10	0
Site 10 Street Address_1	Network Switch	2		1	-1	0	1	-1	0	1	-1	0
Site 10 Street Address_1	Server Peripherals	1		0	-1	0	0	-1	0	0	-1	0
Site 10 Street Address_1	Web Server	1		0	-1	0	0	-1	0	0	-1	0
Site 11 Street Address_1	Network Switch	2		1	-1	0	1	-1	0	1	-1	0
Site 11 Street Address_1	Notebook	51		1	-50	1	1	-50	1	1	-50	0
Site 11 Street Address_1	Server Peripherals	3		0	-3	0	0	-3	0	0	-3	0
Site 11 Street Address_1	Web Server	3		0	-3	0	0	-3	0	0	-3	0
Site 12 Street Address_1	Desktop	6		1	-5	0	1	-5	0	1	-5	0
Site 12 Street Address_1	Network Switch	2		1	-1	0	1	-1	0	1	-1	0
Site 12 Street Address_1	Server Peripherals	4		1	-3	0	1	-3	0	1	-3	0
Site 12 Street Address_1	Web Server	2		0	-2	0	0	-2	0	0	-2	0
Site 13 Street Address_1	Desktop	17		3	-14	3	3	-14	3	2	-15	0
Site 13 Street Address_1	Network Switch	10		3	-7	0	3	-7	0	3	-7	0
Site 13 Street Address_1	Server Peripherals	1		0	-1	0	0	-1	0	0	-1	0
Site 13 Street Address_1	Web Server	1		0	-1	0	0	-1	0	0	-1	0
Site 14 Street Address_1	Notebook	13		1	-12	0	1	-12	0	1	-12	1
Site 14 Street Address_1	Server Peripherals	3		0	-3	0	0	-3	0	0	-3	0
Site 14 Street Address_1	Web Server	3		0	-3	0	0	-3	0	0	-3	0
Site 15 Street Address_1	Network Switch	1		1	0	0	1	0	0	1	0	0
Site 15 Street Address_1	Notebook	23		11	-12	0	11	-12	0	11	-12	0
Site 16 Street Address_1	Notebook	200		200	0	0	200	0	0	200	0	0
Site 16 Street Address_1	Server Peripherals	3		1	-2	0	1	-2	1	1	-2	0
Site 17 Street Address_1	Notebook	23		1	-22	0	1	-22	0	1	-22	0
Site 17 Street Address_1	Web Server	2		1	-1	0	1	-1	0	1	-1	0
Site 18 Street Address_1	Network Switch	2		1	-1	0	1	-1	0	1	-1	0
Site 18 Street Address_1	Workstation	4		0	-4	0	0	-4	0	0	-4	0
Site 19 Street Address_1	Uninterruptable Pow	2		0	-2	0	0	-2	0	0	-2	0
Site 19 Street Address_1	Workstation	3		1	-2	0	1	-2	0	1	-2	0
Site 2 Street Address_1	Network Switch	42		42	0	0	42	0	0	40	-2	0
Site 2 Street Address_1	Notebook	55		55	0	0	55	0	0	55	0	0
Site 2 Street Address_1	Server Peripherals	3		2	-1	0	2	-1	0	2	-1	0
Site 2 Street Address_1	Workstation	4		2	-2	0	2	-2	0	2	-2	0
Site 20 Street Address_1	Notebook	21		10	-11	0	10	-11	0	10	-11	0
Site 21 Street Address_1	Desktop	10		5	-5	5	5	-5	5	5	-5	0
Site 21 Street Address_1	Network Switch	6		5	-1	0	5	-1	0	5	-1	0
Site 22 Street Address_1	Network Switch	1		1	0	0	1	0	0	1	0	0
Site 22 Street Address_1	Notebook	9		1	-8	0	1	-8	0	1	-8	0
Site 3 Street Address_1	Server Peripherals	1		0	-1	0	0	-1	0	1	0	0
Site 4 Street Address_1	Network Switch	6		3	-3	0	3	-3	0	3	-3	0
Site 4 Street Address_1	Notebook	48		3	-45	0	3	-45	0	3	-45	0
Site 4 Street Address_1	Server Peripherals	2		0	-2	0	0	-2	0	0	-2	0
Site 4 Street Address_1	Web Server	2		0	-2	0	0	-2	0	0	-2	0
Site 5 Street Address_1	Network Switch	1		0	-1	0	0	-1	0	1	0	0
Site 5 Street Address_1	Server Peripherals	1		0	-1	0	0	-1	0	0	-1	0
Site 5 Street Address_1	Web Server	1		0	-1	0	0	-1	0	0	-1	0
Site 5 Street Address_1	Workstation	4		0	-4	0	0	-4	0	1	-3	1
Site 6 Street Address_1	Notebook	15		1	-14	0	1	-14	0	1	-14	0
Site 6 Street Address_1	Server Peripherals	5		1	-4	0	1	-4	0	1	-4	0
Site 6 Street Address_1	Web Server	3		0	-3	0	0	-3	0	0	-3	0
Site 7 Street Address_1	Desktop	25		0	-25	0	0	-25	0	0	-25	0
Site 7 Street Address_1	Network Switch	2		0	-2	0	0	-2	0	0	-2	0
Site 7 Street Address_1	Server Peripherals	2		0	-2	0	0	-2	0	0	-2	0
Site 7 Street Address_1	Web Server	2		0	-2	0	0	-2	0	0	-2	0
Site 8 Street Address_1	Network Switch	22		0	-22	0	11	-11	0	11	-11	0
Site 8 Street Address_1	Notebook	22		0	-22	0	11	-11	0	11	-11	0
Site 8 Street Address_1	Server Peripherals	1		0	-1	0	0	-1	0	0	-1	0
Site 8 Street Address_1	Web Server	1		0	-1	0	0	-1	0	0	-1	0

Figure 7: Status Timeline Sample

This timeline view was developed by extracting the Live Quantity of product orders for each site, and each product type, from the Snapshot View. The data is tagged to show the date that the Snapshot was taken, and summary calculations display the Net order quantity differences between live order volumes and the Site Plan requirements. Net (calculated as the sum of the Absolute Value of the difference between Live QTY and Site Plan QTY). Over time (moving to the right in the timeline view) you can see the total Live order quantity for all products increasing as more orders are place to meet the Site Plan requirements. "At Risk" volumes are also tracked, showing changes as the OEM PM takes actions to either accelerate deliveries or adjust the site plan. Over the entire duration of the deployment, the volumes of each of these attributes can be charted and used to show progress through the site plan and measures of average At-Risk volumes. Additionally, each site and each product are tracked over time, enabling the OEM PM to deliver site specific reporting to show progress or challenges against individual Site requirements. Individually, as shown in Figure 7, simple color coding through Conditional Formatting can help a PM identify exactly when changes in Live QTY are made, enabling them to troubleshoot gaps in the delivery timeline due to unexpected changes in the supply chain.

Cyclic Routine

With the Site Plan, Data Plan, and Monitoring plans in place, execution of the initial product orders can begin. As orders are entered into the OEM Order Management System (unique per OEM), demand signals will flow through normal channels into the supply chain. For Dell, the OSR data is available once orders are placed, and as the manufacture and fulfillment mechanisms begin to execute, updates will begin to be reflected in the OSR. To tap into that data, then, and begin to leverage the Snapshot and Timeline dashboards, the OEM PM will need to establish a standard cyclic routine. Based on the Data plan (and related spreadsheet dashboards) created for the case model the PM will need to execute the steps in Table 10 each time new data is available.

PM Cyclic Routine	
1.	Obtain new OSR or specific manually tracked data
2.	Verify the data meets the Data Plan requirements (exa. no duplicated order numbers in the OSR, manually entered ship method has a defined transit time)
3.	Copy the OSR into the data input section of the dashboard workbook (Or add data to the Manual Data Tab, per the Manual Input Method)
4.	Refresh All Pivot tables
5.	Validate Data Integrity by verifying sums: Does total product quantity match known numbers? do site quantities/names still match Site Plan (this step is to ensure the new data was accurately added to the workbook)
6.	Update the Timeline View to record the new data.
7.	Compare the new Timeline view to the Snapshot to verify they show the same data (another validation checkpoint to ensure data integrity, both views should match at the time new data is added)
8.	Analyze each view of the Snapshot to determine project progress, identify risks, identify supply chain anomalies
9.	Use the updated Snapshot and Timeline data to execute communications, change management, and corrective actions per the established project plan

Table 10: OEM PM Cyclic Routine

Chapter 6: Summary and Conclusions

PROJECT MANAGEMENT APPLICATIONS

In prior sections, I presented a series of concerns and complications that can cause a Multi-Source, Multi-Site deployment to miss key timeline and cost targets. The Methodology in Chapter 5: Managing the Multi-Source, Multi-Site Deployment Data was designed to assist a PM is filtering through recurring Supply Chain status reports to develop a comprehensive view of an ongoing execution. That information alone does will not drive a successful deployment, and the PM is challenged with leveraging that information to make decisions, influence stakeholders, and manage resources as necessary to meet the overall program targets.

The Project Management Institute <PMBOK> groups much of the key actions necessary to execute a MS-MS deployment into the "Executing" and "Monitoring and Controlling" process groups. These groups of activities are described as "the process of tracking, reviewing, and regulating the progress to meet the performance objectives defined in the project management plan". In the specific case of MS-MS deployments, the Site Plan described above is one element of the overall project plan, and the Status Snapshot and Timeline dashboards represent part of the tools and techniques available to the PM to help Direct and Manage the Project Execution. These components, however, are only a subset of the overall planning and execution mechanisms necessary for a successful deployment. If developed and implemented fully during a deployment, the dashboards can also support aspects of Project Time Management, Communications Management, and Risk Management, as described in the PMBOK.

PMI also categorizes actions taken to effect changes in the direction of a project as Corrective Actions, Preventive actions, and Defect Repair. The methodology defined above for MS-MS deployments can provide indicators of at-risk orders, and missed deadlines that can enable actions in each of those 3 categories. One key attribute of the MS-MS deployment method is the ability to identify, but target site, what dates on a deployment schedule are at risk. While corrective and preventive actions can be taken to adjust schedule risks by manipulating the supply chain, the dashboards also provide an easily consumable overview of project progress that can facilitate changes to the Site Plan (Project Schedule) through a formal change control process. By identifying and grouping sites that will be challenged to execute as scheduled, the Site Plan can be adjusted to focus resources onto sites that are at lower risk rather than taking the more costly route of accelerated shipping and expedited manufacture.

In the Last Planner method of project management, the PMI concepts of project control are examined and described as largely ineffectual. Ballard characterizes the PMI approach by noting that for the PMI, "project control consists of monitoring progress toward project objectives and taking corrective action when the ship appears to be off course… The objective is to detect negative variances from target, so corrective action can be taken". He suggests taking a "Production Control" approach in which actions are taken to meet the prerequisites of scheduled work before it is allowed to proceed. This is in contrast to the Project Control approach, where work is driven to execute on the project schedule, and corrective actions are taken as necessary when indications show that specific tasks are not proceeding as expected. As applied to the MS-MS deployment, the concept in the Last Planner system is that a Site would not be scheduled for installation until all pre-requisites for the technical work are met. Specifically, Sites would not be scheduled for deployment until all material procurement for that site is delivered. As noted earlier, having the material on site for too long, however, causes risk to the material and impact to the customer's business operations. Leveraging the Status Snapshot and Timeline developed in Chapter 5, however, it is conceivable that a balance can be maintained where a Site is not scheduled for deployment until all material reaches a pre-determined status in the supply chains. With slight modifications, the MS-MS process can be adapted to identify sites that are "X" or more days from being delivered complete, at which point the site is actually scheduled for technicians to arrive and deploy gear. Within a window defined by production lead times and average transit times (already components of the MS-MS process), the value of X (days until material is on-site) can be set as part of the project plan. With that established, a cyclic routine can be envisioned whereby specific sites are scheduled (within the context of a broader timeline) based on actual supply chain progress, instead of attempting to bend the global supply chain to meet a pre-defined Site schedule. By accepting the variability present in supply chain execution, the risk of having technicians on-site without the proper equipment to complete the technology installation can be reduced.

SUMMARY

The Multi-Source, Multi-Site deployment is a complex balance of multiple competing timelines that can be affected by a wide variety of influences. Perturbations in global supply chains, manufacturing schedules, and local shipping capacities insert variations in cycle times that OEM's experience between receiving an individual customer orders and delivering product on site. Those variations are compounded when attempting to control delivery activities within small time windows across a variety of products supplied by multiple vendors. It is the task of a deployment project manager to interpret a variety supply chain signals and identity any risks in meeting defined delivery schedules. Additionally, each MS-MS deployment will have different customer requirements, site requirements, and timeline pressures. With that amount of variability, the PM will benefit from a structured approach to defining what supply chain data is available and how it can be used to help manage expectations, monitor execution, and effect the overall deployment success.

In this paper, I presented an approach that breaks the planning into 3 primary deliverables; the Site Plan, the Data Plan, and the Monitoring Plan. Executing those three plans will drive a PM to understand the supply chain data available to them, translate that data into information useful and understandable by all stakeholders, and monitor the progress of the supply chain against the deployment schedule. In practical terms, those plans culminate in a data mining and data management methodology that can be supported with spreadsheet based dashboards that provide both a fixed Snapshot of the status of the deployment as well as a Timeline of key material movements over the duration of the deployment.

The Status Snapshot and Timeline provide information to the PM that will give them insight into timeline risks and supply chain challenges. Incorporating that information into the overall Project Management methodology was not explored in this paper, and is a valid topic for further investigation. With a clearer picture of supply chain execution, however, a PM tasked with a Multi-Source, Multi-Site deployment can better leverage existing project change controls to improve their chances of successfully meeting their schedule and cost targets.

Appendix A: Project Scoping Framework

Table A1 lists standard project scoping questions that solution architects use today to understand the details of a managed customer engagement. These questions cover a wide range of potential support activities, including the underlying risks of MS-MS Deployments.

Project Scoping Framework
Is this engagement the result of RFP/RFQ or RFI?
Is this project customer facing?
Intake Mgr has scoped/received SOW approval?
Has Intake Mgr confirmed Ops PM deliverables?
Is a re-scope required after project kickoff meeting?
Has the project qty been confirmed? Project vs. Run Rate?
Has the project timeline been confirmed?
Has the preliminary project been loaded into Sharepoint?
Is this a project renewal or refresh of an existing project?
Has the project been assigned to an Ops PM?
Has there been an Ops PM pricing agreement? (per unit, per quarter, or per month?
Was the customer quoted prior to PM engagement?
Project Specific Details
Does this project/program involve a reseller? (Who?)
Is there Alliances involvement (GD, LM, NG)?
Is the customer's project funded?
Is any element of the project restricted to US only citizens?
Will any product be shipped OCONUS? Where?
Will purchases be project or run rate based?
Is the LOT qty and probability accurate in SFDC?
Who is the finance person for this project?
Does the customer encourage direct contact with the PM?
Will DOD UID labeling be required on any or all equipment?

Project Scoping Framework
Is EPEAT and/or ESTAR a requirement for the equipment?
Known contract vehicle for this project (SEWP, ITES, GSA?
Pre-Order Solutioning
B2B, Premier or Global Portal requirements? Is it new or existing?
Is there a contractual SLA? What is it? Is SLA Mgr. engaged?
Is there a dedicated ASR or OP for this customer project?
Order Placement: Bulk vs. Staggered
Will the project span a product transition?
Will integrator or vendor management be required? Who?
Has there been a partner agreement or SOW provided?
Custom Factory Integration
Is CFI required on the project? Who is the CFI PM?
Is a customer provided or custom image required?
Asset tags required: consigned or Dell managed?
Hardware integration (DiB): S&P or Dell branded
Is CFI reporting needed for IP addresses, or product info?
Custom Fulfillment Solutions (CFS)
Does product need consolidation, tagging, RNS, etching, or other CFS services?
Shipping & Delivery requirements
Will the project require delayed or staggered delivery?
Are special carriers or white glove delivery services required?
Consolidated, staggered delivery or basic build and ship?
Is the customer requiring special OCONUS deliveries?
Any other special delivery requirements (date-specific, time-specific, inside delivery, etc)?
Invoicing
Does the customer have special invoice requirements?
Custom invoices: Do they requires Controller approval?
What is the customer's net terms?
Will PM intervention be needed to meet invoicing requirements?
Reporting
Are there any reporting requirements for the project?
Is a custom report being managed today? Example of report?

Project Scoping Framework
CARS: Self Serve
Custom Reporting
Communication
Is there a preference in establishing a weekly call?
Who is the preferred lead PM when managed services is engaged? Sales Ops or Services?
Managed Services
Does this project involve Managed Services?
Are services being performed by Dell? Other?
Who is the Services PM for this project/program?

Table A1: Project Scoping Framework

Appendix B: The MS-MS Status Snapshot

A primary objective of this paper is to develop a methodology for managing MS-MS deployments that is accessible to OEM PM's without the need for advanced databasing skills, customized application development or purchase, or complex macro execution within a spreadsheet. The concepts presented in this paper are general enough to apply to a variety of deployment activities, but the OEM PM needs a simplified method for applying those concepts in order to have a direct impact. The workbook architecture presented here is the foundation that a Dell PM can use to implement the Monitoring Plan described earlier, using the OSR as the baseline source data. It was developed for ease of use by a PM, but was strictly limited to standard cell-reference functions, pivot tables, and other Excel features.

To operationalize the Data Plan described in Chapter 5, the MS-MS workbook must incorporate a Translator and a Manual Input Method for manipulating the source data. At the same time, the workbook should be flexible enough to accept variations in the source data and robust enough to preserve information even if inaccurate, or "bad" data is inserted. To that end, the following philosophies apply:

1. Updating the OSR data should involve only importing a whole worksheet. Errors are too easily inserted if a PM is required to routinely select specific cells within a worksheet to cut & paste into another
2. The OSR data should not be changed by the process. It should serve as a fixed input

3. The PM should not be required to perform any Cell manipulations to update the workbook. Changing cell references, formulas, or content will eventually result in errors compounded through the deployment
4. The Workbook should provide some forms of "checksums", general data integrity validations that provide feedback to a PM that the data is reliable
5. Output views should be easily copied to other standard formats for outbound reporting to stakeholders via the Project Communications Plan
6. Any pivot tables should have very limited filters and require limited interaction from the PM, so that all data in the OSR is accounted for. Filtering out data can mask unpredictable errors
7. Any error checking should provide obvious indications to the PM that there are issues in the data stream that should be investigated. Care must be taken when masking Lookup and Reference failures with IFERROR and ISERROR functions

With those concepts in mind, the MS-MS Workbook was developed as follows

1. <u>Establish the Site Plan:</u> One sheet in the MS-MS workbook contains the site plan. This is a flat presentation of the plan with only key data present, but with no gaps in the spreadsheet. This sheet should involve no functions or calculations and holds the latest approved plan. A Pivot of this table can be generated to provide a more visually pleasing view of the data, but the Plan should be maintained accurately in this flat format (Figure B1). Note, updates to the site plan in this format can be cumbersome, care must be taken to ensure that all records for each site reflect the same TDD.

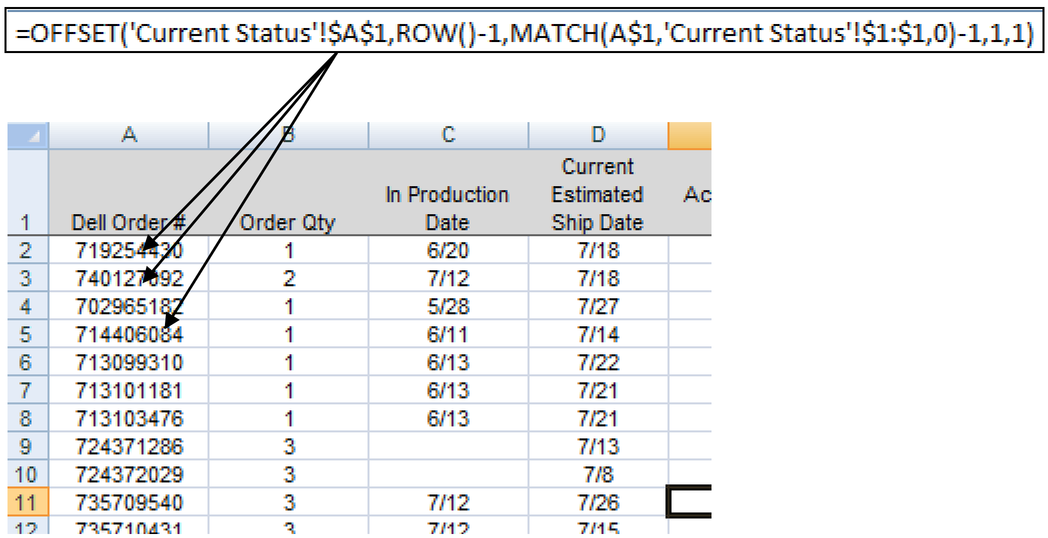
Site	Customer PO #	Target On-Site date	QTY	Product Line
Site 1 Street Address_1	PO-Client	7/24	95	Desktop
Site 1 Street Address_1	PO-enterprise	7/24	75	Network Switch
Site 1 Street Address_1	PO-Client	7/24	200	Notebook
Site 1 Street Address_1	PO-enterprise	7/24	3	Server Peripherals
Site 1 Street Address_1	PO-enterprise	7/24	2	Web Server
Site 10 Street Address_1	PO-Client	8/8	11	Desktop
Site 10 Street Address_1	PO-enterprise	8/8	2	Network Switch
Site 10 Street Address_1	PO-enterprise	8/8	1	Server Peripherals
Site 10 Street Address_1	PO-enterprise	8/8	1	Web Server
Site 11 Street Address_1	PO-enterprise	7/25	2	Network Switch
Site 11 Street Address_1	PO-Client	7/25	51	Notebook
Site 11 Street Address_1	PO-enterprise	7/25	3	Server Peripherals
Site 11 Street Address_1	PO-enterprise	7/25	3	Web Server
Site 12 Street Address_1	PO-Client	7/23	6	Desktop
Site 12 Street Address_1	PO-enterprise	7/23	2	Network Switch
Site 12 Street Address_1	PO-enterprise	7/23	4	Server Peripherals

Figure B1: Site Plan in MS-MS Workbook

2. Update the OSR Data: The OSR is a report generated by Dell's internal reporting systems and delivered to a PM as a worksheet attachment to an email. Typically, this is a daily report. The OSR data occupies one worksheet in the MS-MS Workbook (the 'Current Status" tab) and is imported by selecting all the data from the original OSR worksheet and pasting it into the MS-MS workbook. No other manipulations are required.
3. Populate the Order Checker: Identify relevant columns in the OSR, and port that data into a separate worksheet through simple Offset and Match functions. 'Order Checker' is a sheet in the MS-MS workbook that consolidates data and allows for calculations. The structure used here requires that the column headings in the Order Checker sheet match exactly the text of the column headings in the OSR. The

column order in the OSR can vary, based on options selected by the PM, so I developed the workbook to allow for the columns to exist in any order in the OSR This was accomplished as follows:

a. Figure B2 shows the section of the Order Checker worksheet containing a view to the OSR data. The header row (1:1) contains the exact text of the columns in the OSR that are needed. Each cell below contains the formula below:

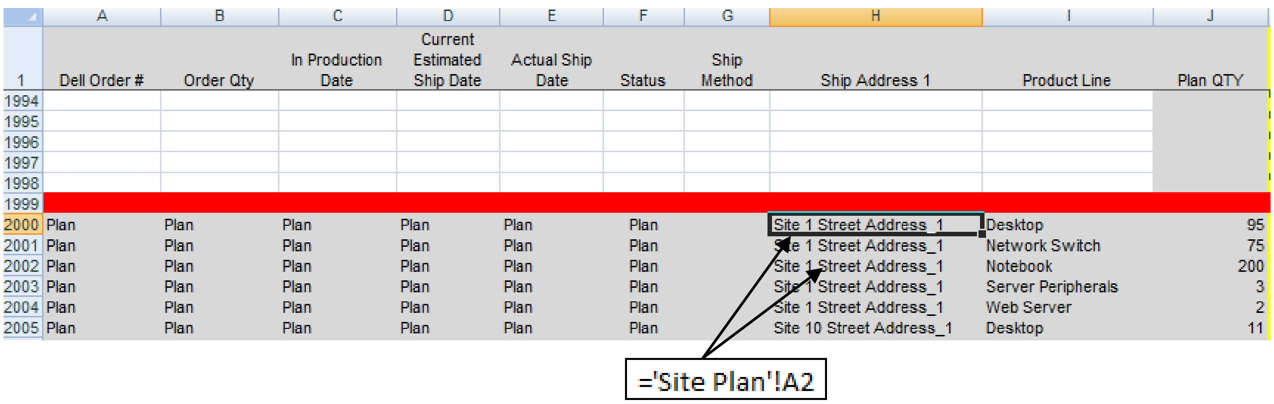


	A	B	C	D	
1	Dell Order #	Order Qty	In Production Date	Current Estimated Ship Date	Ac
2	719254430	1	6/20	7/18	
3	740127092	2	7/12	7/18	
4	702965182	1	5/28	7/27	
5	714406084	1	6/11	7/14	
6	713099310	1	6/13	7/22	
7	713101181	1	6/13	7/21	
8	713103476	1	6/13	7/21	
9	724371286	3		7/13	
10	724372029	3		7/8	
11	735709540	3	7/12	7/26	
12	735710431	3	7/12	7/15	

Figure B2: Order Checker with OSR Data

'Current Status' is the worksheet that contained the OSR data. This populates each cell with the related OSR data, based on matching the heading in the OSR to the heading in the Order Checker tab. This formula is copied down to row 2000 in the order checker sheet, allowing for up to 2000 records to be present in the OSR. Rows below 2000 are used for other information as described below.

b. The Order Checker sheet also needs to contain the Site Plan data. Having both the OSR data and the Site Plan data in one sheet facilitates some presentation functions later without needing specialized macros. Site plan data is loaded into the Order Checker sheet starting at row 2000, using simple lookups, shown in Figure B3



	A	B	C	D	E	F	G	H	I	J
1	Dell Order #	Order Qty	In Production Date	Current Estimated Ship Date	Actual Ship Date	Status	Ship Method	Ship Address 1	Product Line	Plan QTY
1994										
1995										
1996										
1997										
1998										
1999										
2000	Plan	Plan	Plan	Plan	Plan	Plan		Site 1 Street Address_1	Desktop	95
2001	Plan	Plan	Plan	Plan	Plan	Plan		Site 1 Street Address_1	Network Switch	75
2002	Plan	Plan	Plan	Plan	Plan	Plan		Site 1 Street Address_1	Notebook	200
2003	Plan	Plan	Plan	Plan	Plan	Plan		Site 1 Street Address_1	Server Peripherals	3
2004	Plan	Plan	Plan	Plan	Plan	Plan		Site 1 Street Address_1	Web Server	2
2005	Plan	Plan	Plan	Plan	Plan	Plan		Site 10 Street Address_1	Desktop	11

Figure B3: Order Checker with Site Plan Data

'Site Plan' is the sheet in the MS-MS workbook where the Site Plan (Figure B1) resides.

4. <u>Establish the Translator:</u> With the OSR data and Site plan data ported into the Order Checker sheet, the next step is to apply the analytics defined in the data plan. Several constants were defined in the data plan, and those are maintained in the 'Translator' sheet (Figure B4). They include the Transit Time associated with each Ship Method, the allowable dwell time in "IP" status before an order is considered unhealthy, and the Early/Late delivery window that establish when an order is at risk.

Order Snapshot Validation			
Ship Method	***Transit Time***		note- ship method must match data stream text exactly
LTL 3 to 5 days service	**5**		This is a lookup table that drives EDD calculations
Next Day	**2**		
Health Check	7	<-- Max number of days IP to be a healthy order	
Timeline risk if EDD>TDD by	0	days or more late, "0" means it cannot be late by even 1 day	
Timeline risk if EDD<TDD by	10	days or more early	

Figure B4: The Translator Worksheet

5. Perform Translations: Within the Order Checker sheet, calculations can be made on the OSR data and the Plan data to determine the translated Status of each individual order. Figure B5 shows a sample of the resulting data

	I	J	K	L	M	N	O	P	Q	R	S	Formula Bar		V	W	X
1	Product Line	Plan QTY	EDD_Calc	TDD	TDD-at-risk	IP Order Health	Live?	Not in Site Plan = 0	TDD-at-risk QTY	DTP-Live	DTP-Not Shipped	Live not shipped	Cancelled	long IP	shipped	Live
2	Workstation		7/11	7/21	Good	Invoiced	Live	5	0			0	0	0	1	1
3	interruptable Power Supply		7/14	NOT In Site	NOT In Site Plan	Invoiced	Not in Site	0	0			0	0	0	2	2
4	Server Peripherals		7/16	7/30	Risk-Early	Invoiced	Live	11	1			0	0	0	1	1
5	Desktop		7/3	7/17	Risk-Early	Invoiced	Live	3	1			0	0	0	1	1
6	Notebook		7/27	7/28	Risk-Late	Stuck IP	Live	1	1			1	0	1	1	1
7	Notebook		7/21	7/24	Good	Invoiced	Live	1	0			0	0	0	1	1
8	Notebook		7/21	7/24	Good	Invoiced	Live	1	0			0	0	0	1	1
9	Desktop		cancelled	cancelled	cancelled	cancelled	cancelled	3	0			0	3	0	3	0
10	Network Switch		cancelled	cancelled	cancelled	cancelled	cancelled	1	0			0	3	0	3	0

```
=IF(L3="not in Site Plan",L3,IF(F3="cancelled","cancelled",IF(TDD+Translator!$B$12>=EDD,IF(TDD-Translator!$B$13<=EDD,"Good","Risk-Early"),"Risk-Late")))
```

Figure B5: Applied Translations in the Order Checker

Calculations for each field include error checking and data smoothing designed to deliver useful output to the PM. The TDD-at-Risk calculation, for example, is shown for cell M3. The results on the right hand cells in figure B5 are summations of the quantities of each order that apply to each category, based on the translations (translations highlighted in yellow). Similar calculations are performed against each item in the Site Plan, in rows 2000 and below on the Order Checker sheet. The "Delta to Plan" (DTP) columns are calculated against the plan data, not the OSR order data.

6. <u>Display the Status Snapshot:</u> With the Translation calculations completed in the Order Checker tab, status results can be presented to the PM. This is done through a Pivot of the data in the Order Checker sheet. One of the goals here was to keep the manipulations required of the PM to a minimum, but also present the information as concisely as possible. The result was a single sheet that allows multiple views of the status information (screen shots were presented in Chapter 5). To enable that functionality, a pull-down menu is presented to the PM on the Snapshot sheet that allows the PM to select the view they want. Note, this is not a Pivot Table Page Filter, but was designed to look similar, see Figure B6.

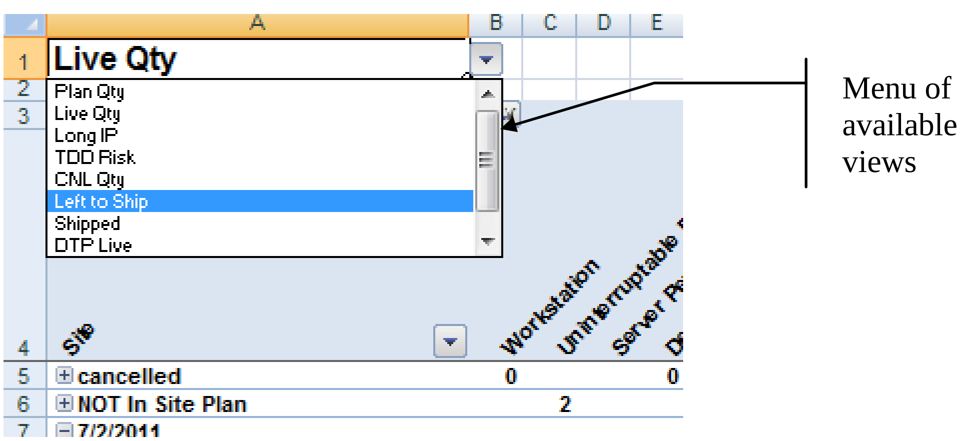


Figure B6: Snapshot Menus

Once a view is selected, a separate VLOOKUP reference is made to determine what data in the Order Checker the PM is looking for. Each selection in the view menu is mapped to a specific column in the Order Checker, and the data in that column is used in the final Status Snapshot Pivot (Figure B7).

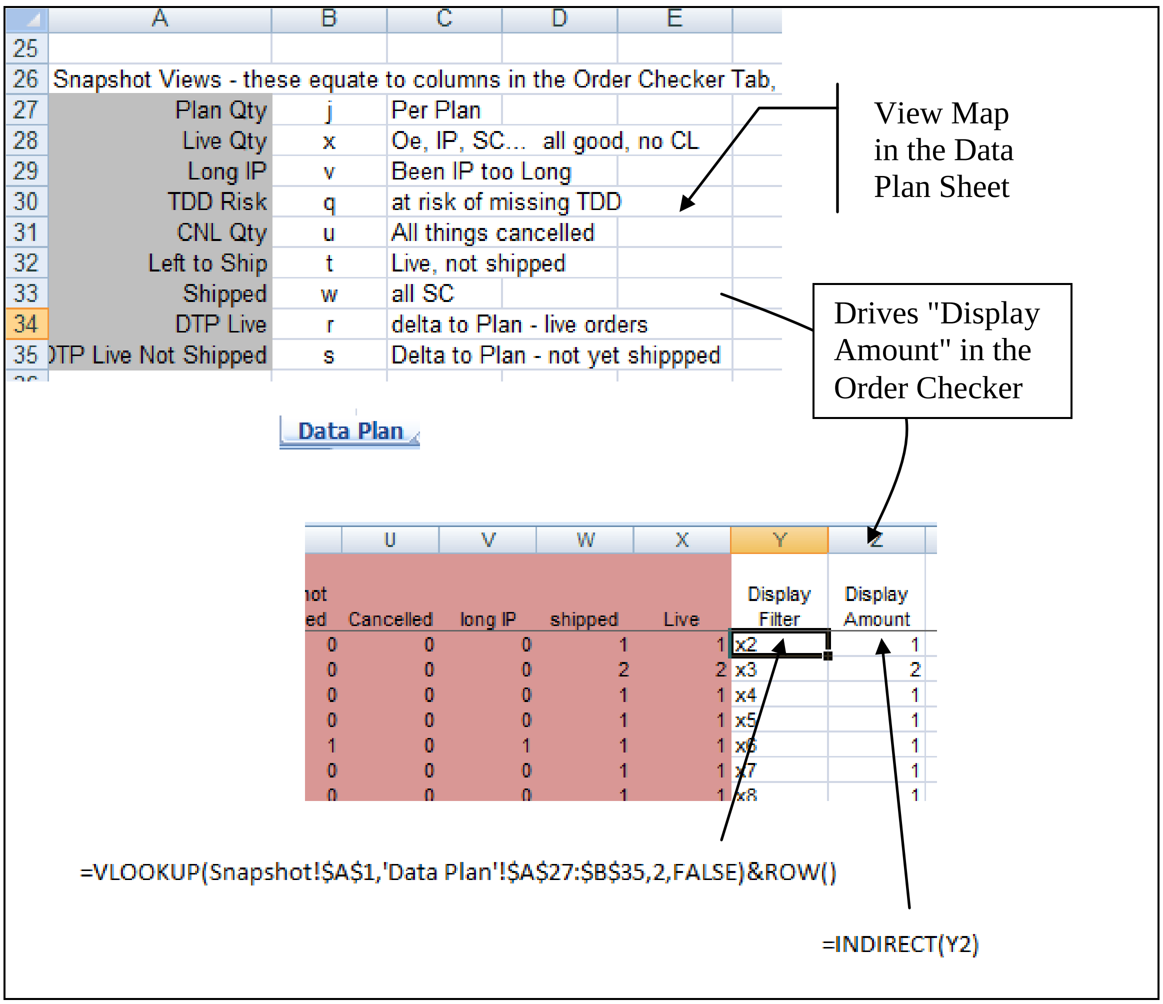


Figure B7: Snapshot Data Mapping

This mapping and reference-based data population is a bit cumbersome to establish initially, but accomplishes the goals of limiting the amount of interaction the PM must have with the underlying data and logic in order to get the relevant Snapshot data.

The workbook architecture presented above requires some specific data controls, but in execution on the PM's cyclic routine (as defined as part of the Monitoring plan) there are minimal requirements for a PM to extract useful information. This structure also adds some flexibility including the ability to accept various OSR reporting (column sequence doesn’t matter, and the headers are defined as corporate reporting standards that cannot be changed). Also changes to the Site plan are automatically incorporated into the reporting, and adjustments can be made easily to the definitions of At-Risk orders and unhealthy orders.

Using this framework, additional calculations can easily be added to the Translator and Order Checker to provide additional views of the OSR and Site Plan information directly into the existing Snapshot display.

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