Offering
Autodesk® Infrastructure Design Suite 2013 Ultimate Edition
AutoCAD® Utility Design 2013
AutoCAD® Map 3D 2013
Autodesk® Consulting Services

An Approach to Integrated Design and Asset Data Management Workflows

Utilities are challenged to improve efficiency and operations as they update their aging network assets and implement more complex smart grids. An integrated design and asset management workflow can help utilities improve efficiency, enhance asset selection and accounting, and improve data quality as a foundation for better safety, reliability, and compliance. This paper explores one approach to implement an integrated workflow in an environment, with solutions including AutoCAD® Utility Design and AutoCAD® Map 3D software, as well as common utility enterprise asset management systems such as SAP®.

Contents

www.autodesk.com/map3d
www.autodesk.com/autocadutilitydesign
www.autodesk.com/infrastructuredesignsuite

Autodesk®

Utility Architecture Framework

Although utility business systems vary by utility depending on size and the IT history of the utility, there are certain systems that are representative of a typical utility architecture framework.

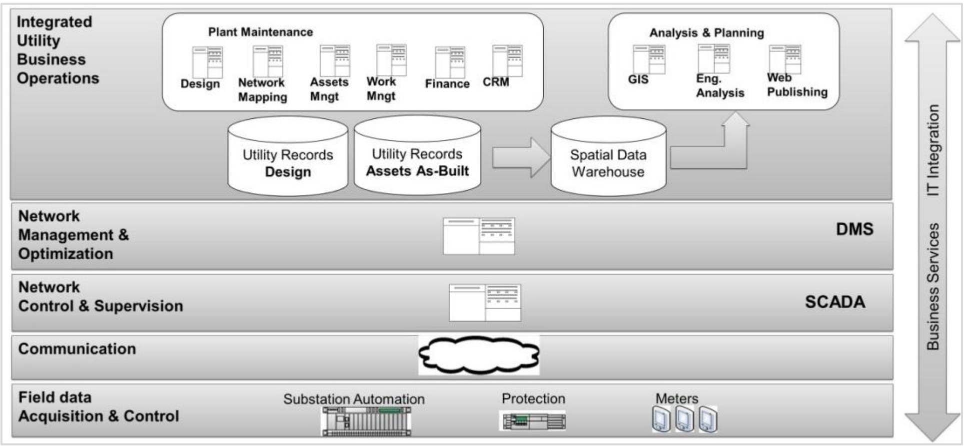

Figure 1: Typical utility architecture

Figure 1 shows five major business areas of a typical utility (as swim lanes) that should work together to support the utility's business workflows. All processes and systems are an attempt to achieve two main goals: most importantly, providing safe and reliable service to customers; and creating and maintaining the supporting utility infrastructure of assets connected in the network.

The Integrated Utility Business Operations layer is where back office or backbone enterprise systems exist. These can be divided into Plant Maintenance and Analysis & Planning groups.

Plant maintenance includes design and mapping software such as AutoCAD® Utility Design, AutoCAD® Map 3D, and other third-party solutions. These software products support the creation of new assets on the system (line extensions, new facilities to serve new commercial or industrial load, new smart grid systems) as well as the removal and replacement of aging assets. Design software can reference existing conditions, lay out and engineer new facilities, create construction documentation and bills of materials (BOMs), and create an extension of the network model. Mapping systems can take the design data and as-built changes and commit this information to the system of record.

Plant maintenance also includes work management, asset management, finance, and customer information systems. Some of these applications are also offered in enterprise resource planning (ERP) solutions. Along with the design and mapping systems, these systems are responsible for creating and managing asset data. The main objective is to produce and maintain a consistent view of the utility network, where records in these systems accurately identify attributes of assets in the field.

Many vendors offer solutions in these categories. SAP systems are frequently encountered for ERP and work and asset management, and will be the main focus of this paper.

Once data is in this consistent state (or "as-built" state) it is published from the Plant Maintenance group to the spatial data warehouse, where it is made available for analysis and planning systems.

Systems in the Analysis and Planning group consume as-built network data and provide recommendations on potential system upgrades or changes to accommodate growth, expected changes in generation, and smart grid programs. Engineering analysis systems (such as CYMDIST and SynerGEE®) are used in these groups. The geographic information system (GIS) is also included in this group—often used by planners for right-of-way assessment or environmental impact planning for future network expansion. In some utilities, GIS and mapping is regarded as a single functional group, although the utility may use multiple applications in this area.

Published as-built data from the spatial data warehouse are also available to the next important business layer, Network Management & Optimization. This is where utilities use distribution management systems and other tools to analyze runtime parameters and provide recommendations to reconfigure the network for optimal performance. Recommended changes can be applied by supervisory control and data acquisition (SCADA) systems as part of network control and supervision—at this level the system communicates to field devices and reconfigures the network to isolate issues (such as outages).

In order to control devices in the field utilities must build a sophisticated and reliable Communication layer. Here you will find many different technologies, like fiber cable links, microwave communication, and others.

And finally, Field Data Acquisition & Control systems are used for switching and control at the device level.

Defining an Asset Management Approach

There is no single solution that will solve asset data management process challenges entirely. Today, however, utilities can adopt a hybrid approach, utilizing excellent plant maintenance systems while establishing a desired "single point of truth" data source for all assets available to enterprise users and applications. The key aspects of the approach are:

- Implement a smooth asset management workflow that supports the entire asset lifecycle
- Validate and consolidate all relevant physical, electrical, and spatial attributes from the plant maintenance systems in a single spatial data repository—the spatial data warehouse (SDW)—and then use this SDW to support operations and business analysis
- Invest in existing data maintenance systems and minimize change management
- Reference a single land base and utilize the strength of data fusion with 3D imagery
- Capture as-built information to support asset management

Autodesk's approach to implementing solutions for an integrated design and asset management workflow is based on three principles:

- Advance business workflow by enabling a smoother data transition between design, build, operate, and maintain business processes that helps protect the data's integrity and helps to minimize data loss.
- Link design and asset as-built records and make them available to all users in the utility
- Implement business process management, including a services middle tier and events-driven architecture integrating systems in a unified business process.

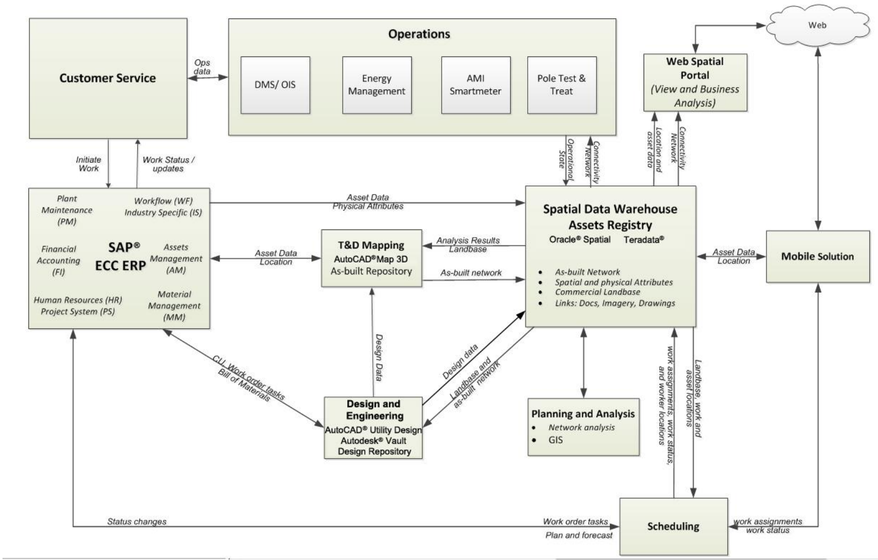

Figure 2: Solution components architecture

With this approach, users will have more confidence that the data used for a particular application are more consistent and fit the purpose at the time of use, thus helping to address the core business objectives of safety, reliability, and compliance. Figure 2 represents high-level major system components and data flows in an integrated utility approach. In this example, the utility has adopted a SAP ERP system and Autodesk® design and mapping solutions.

An Integrated Design and Asset Management Workflow

The basic design and construction workflow steps are:

- A work request (WR) is created in the SAP system.
    - **Result:** WR is assigned to designer.
- The designer launches the design application (AutoCAD® Utility Design). The Utility design solution connects to SAP and gets details of the WR.
    - **Result:** a new design project referencing SAP materials list and compatible units (CU) is created.

- The designer opens the project and works on the electric distribution design. AutoCAD Utility Design connects to as-built spatial repository and displays landbase, structural, and electrical features.
    - **Result:** a subset of required electric network features (as design “take-off” features) is included into the design project.
- The designer completes the design—including drafting, electric connectivity, and engineering analysis—based on the utility’s standards.
    - **Result:** the design project is completed. AutoCAD Utility Design automatically generates the bill of materials and submits BOM to SAP system for estimation of costs.
- SAP system executes design review process.
    - **Result:** Once design is approved, AutoCAD Utility Design generates the construction package and posts the design project for processing to mapping system. A subset of the design data representing new assets and changes to existing assets is imported as a version in long-transaction.
- Construction work is scheduled and assigned to a crew.
    - **Result:** The construction work is completed and as-built markups are collected.

The basic as-built asset mapping workflow steps are:

- The records manager uses AutoCAD® Map 3D software to check that electric connectivity and relationships between features in the posted design are based on the common model and mapping standards.
    - **Result:** the common data model allows for standards and rules to help drive the workflow.
- The records manager reviews design data, and as-built markups are incorporated as appropriate.
    - **Result:** The map better represents as-built assets state in the field.
- Changes to assets from the design project such as creating new, updating/retiring existing assets are communicated to SAP.
    - Result: SAP and mapping as-built repositories are more synchronized and network data is promoted to “live” state and made available to all users and other systems in the utility.

Building the Spatial Data Warehouse

The source systems (asset management, design, mapping, customer information management, finance and work management, scheduling) can all maintain utilities data using commercial off-the-shelf (COTS) interfaces/tools. In this approach, each source system then publishes important and relevant data about facilities and the network’s as-built state into the spatial data warehouse. The publishing process preserves links between assets using system-wide IDs. The SDW will not be edited directly by users or business applications. Any updates will be made within the source systems that “own” the data.

The SDW will merge four primary categories of the vital information about assets:

- Physical characteristics of assets (information about assets including associated documents)
- Geographic location (real-world coordinates of the asset) and other locations (like symbols placement on a schematic map) as continuous map of the entire service territory
- Network topology/connectivity
- Site-specific conditions (information about sites)

The SDW will also house utility and commercial land-base layers covering the entire service territory. The land-base data will be available for direct access from all source systems in a read-only mode and should be refreshed on a periodic basis.

As a result of the above characteristics, the SDW will provide a consolidated, single point of truth database that can be accessed by all business applications with standards-based interfaces either via a direct data connection or via middle-tier services (see Figure 3). This approach also supports visualization of as-built data together with 3D imagery, providing a more real-world view. Moreover, the SDW will allow analyzing utility network assets to help discover trends and create comprehensive reports on the state of the electric network.

Technology Considerations

Although the Autodesk approach has the “spatial” aspect directly in its core, it is not necessarily GIS-centric and is not bound to a specific version of SAP or GIS software. The approach is based on the industry’s best practices and Enterprise Application Integration (EAI) implementation experience. Autodesk’s approach defines middleware components (see Figure 3) to help manage asset updates and relies on business process management (BPM) components to help model, execute, and monitor business processes on a specific process model.

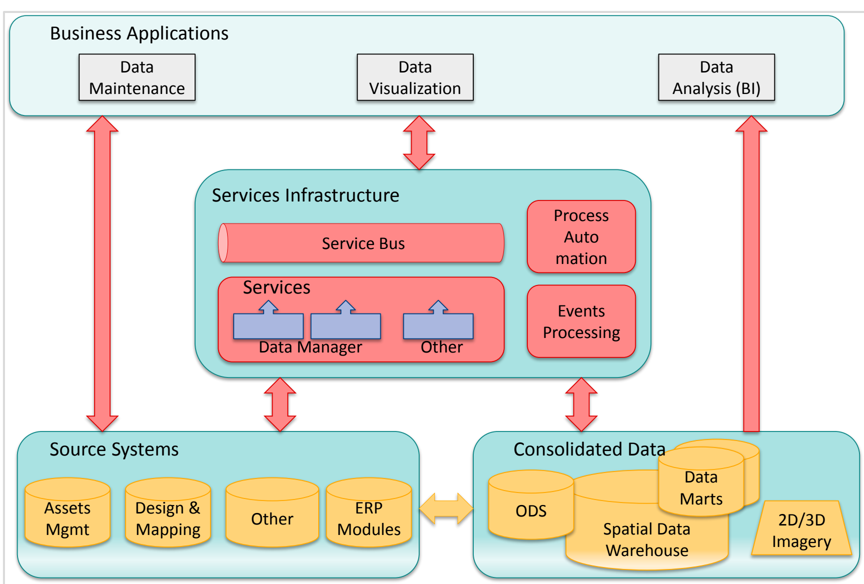

Figure 3: Solution integration architecture

Each business process more clearly defines the rules and exceptions helping to govern the process steps that are performed by people or systems in response to specific business events. The events disseminate incremental changes in business state throughout the utility's enterprise, thus achieving greater data consistency and more reduced latency in updates, as opposed to trying to facilitate data integration in the process layer. For example, Figure 4 demonstrates integration of mapping and design systems to SAP using SAP® NetWeaver® technology platform.

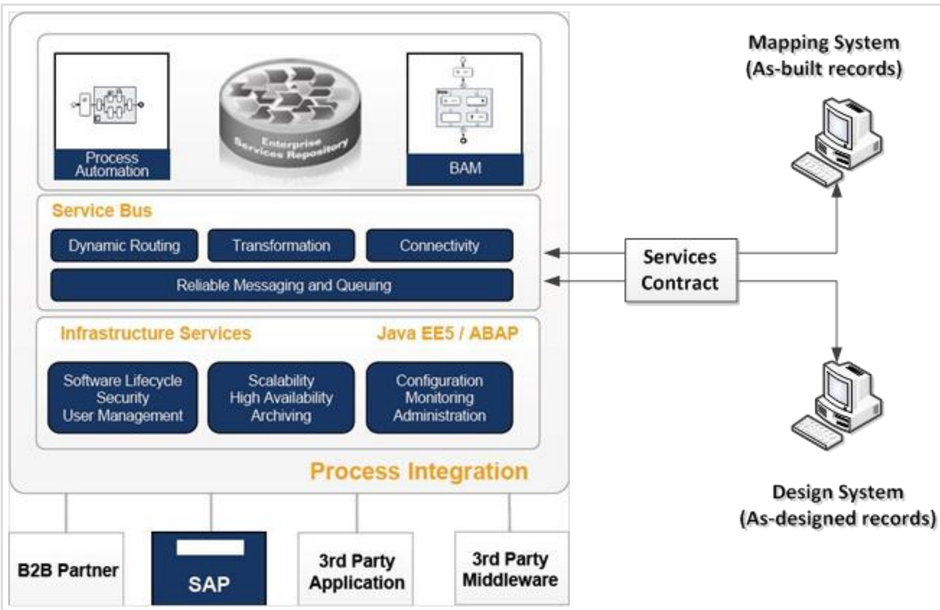

Figure 4: Integration with SAP

Based on experiences implementing similar solutions for utilities, Autodesk strongly suggests a design that completely decouples SAP from design and mapping systems by utilizing services with COTS contracts. Further experience suggests that tight coupling (as sometimes recommended) might amplify user acceptance challenges and system overhead involved in making such interfaces real time, or "synchronous," particularly when users want to undo changes in one system thus triggering rollback in another system, or when a change produces an inconsistent state of data. Another benefit of Autodesk's approach is that neither design/mapping nor SAP systems would be affected by either system being down, or unavailable. Users will be unaware that integration is occurring behind the scenes.

In the Autodesk approach, SAP is the system of record for all assets data and the mapping system is the system of maintenance of SAP functional locations. When an asset update in the mapping system is posted to live status, the list of functional locations in SAP will be updated. The mapping system can also be used to record which equipment is installed at each functional location. This information must be updated in SAP as part of the same process that helps synchronize the functional locations. The network topology can change dynamically as new assets are added and/or reconfigured daily (home meters and other hardware). The Autodesk approach optimizes changes to SAP (asset system of record) as updates are only synchronized once when design changes and as-built markups are incorporated, and network topology is updated as part of a long-transaction state change.

The SAP integration services are shared between design and mapping systems. For example, AutoCAD Utility Design and AutoCAD Map 3D will call the same service to get details of assigned work requests from SAP. AutoCAD Utility Design may also query SAP to get the list of materials from SAP's Materials Master or determine if equipment is available for installation.

The Autodesk approach can work with any commercial middle-tier framework (such as SAP NetWeaver, IBM® Websphere®, Microsoft® BizTalk® Server, or Oracle® Fusion) that supports the required infrastructure services.

Implementation Approach

Implementing a SDW requires a database technology capable of supporting spatial data types (such as Oracle® Spatial, Microsoft® SQL Server®, or Teradata®) and storing location information (geospatial or otherwise), such as longitudes and latitudes, in the same tables and rows as the rest of the data; in essence, location becomes just another data point for facility records. Users and applications can extract spatial data and perform spatial queries on the same data. This approach allows the spatial data stored in the database to be separated from the processing logic included in the GIS software. The SDW may store multiple locations (in various coordinate systems) of facilities in the distribution network. For example, in facilities mapping and design systems, users may place facilities (as map symbols) at the correct geographic location, while in electric circuits mapping users may want to create a schematic representation by placing symbols that represent the same facilities on an offset location as required by mapping standards. Therefore, in the SDW, a facility (device/structure) may have two (or more) geometries associated with it—one for its real-world location (registered with GPS, for example) and others reflecting "mapping locations" as per the drafting/mapping standards enforced by the utility. (Pole location is another example.) The key is that there will be only one record representing the asset in the SDW. As the result, this same asset record can be visualized differently by business applications.

Data changes are continually merged into the SDW from many sources (including commercial land base and imagery). This is done using data integrity and quality services configured using a middle-tier framework of services, as well as Extract-Transform-Load (ETL) tools, to validate and transform data to a common model. Sharing land-base and other relevant data via a standard data access interface provides a common spatial reference and addresses scalability of the solution by eliminating runtime data access to the source systems—data is preprocessed and readily available from the SDW.

Another major component in building a SDW is the operational data store (ODS). An ODS is a database that serves two purposes: it makes integration of data from multiple source systems easier and it stores non-critical operational data. Only non-critical operational data is published. For the most current operational data, enterprise systems (including field mobile) still should query source systems directly. However, source systems can share information about the current as-operating state of the network, as well as identification and restoration of service outages by publishing such data to ODS, thus helping to reduce the load on the source system and making data available to others. The ODS is primarily used by the ETL publishing process to consolidate data. It can also provide access to some published non-critical operational data (for example, work in progress, field crew locations, current outage data, and so on) that will not be published to the SDW. In simple terms, a typical ODS may contain days of information in various stages (for example, work in progress), while the SDW can contain the most current, validated data in the as-built state and years of historic data. Publishing data is a very important concept of the approach—it helps provide predictable system performance for data query and analysis and is a foundation for overall system scalability. It is important to highlight that the approach does not depend on any specific ETL vendor tool (such as SAP BusinessObjects Data Integrator, Informatica®, Oracle® Data Integrator, or Safe® FME). The processes of data publishing are completely decoupled, thus providing greater flexibility in system configuration.

The Autodesk approach relies on the established common model (a derivative from industry standards such as the Common Information Model) to semantically integrate data using common class definitions (including attributes and relationships), domain values, and interface data access contracts. The common model metadata is maintained by ETL tools or other specialized middle-tier components. All source systems posting data updates to an ODS must map model and domain values to the common model elements. The SDW model inherits some of the common model elements but it is tuned for efficient queries execution and analytical support (including spatial analysis).

Another powerful aspect of the Autodesk approach to managing assets is data fusion of 3D imagery (such as from earthmine® and Pictometry®) with facilities records in the SDW to improve situational awareness of users so that they can create better situation assessment plans before arriving on the location. Using geographically indexed panoramic or oblique imagery overlaid with the utilities data, users can better identify conflicts or complications from the office and equip the field crew for the situation at hand. The approach mandates that everything referenced in the SDW data be relevant and compliant as much as possible with the single point of truth concept. While incremental updates from the source systems (in vector and tabular formats data) help maintain this state, imagery (raster format) and video streams cannot be resurveyed each time the as-built state of the network is changed to reflect the most current situation in the field. To address this challenge, special symbols can be overlaid while viewing imagery and video, helping the scene to be as close as possible to the as-built state. For example, if a pole has been removed since the imagery was captured, a special symbol (like “red cross” or “REMOVED” label) can be displayed right on top of the pole in the composition scene, indicating that situation has changed. Keeping all the SDW data sources in sync can greatly improve users’ trust in the data. More trust, and therefore more dependence on the data by users, has a positive snowball effect of those users taking more ownership and responsibility for data quality and correctness. Under those conditions, users finding an asset in the field whose attribute is incorrect are more likely to submit a correction, which can then flow to the system that has governance over that particular data attribute for assets. Once the governing source system has been updated, the SDW will then reflect the corrected information. Data governance decisions must address areas such as operations efficiency, compliance with regulations, protection of assets, and operational resiliency.

Summary

An integrated design and asset management workflow can provide a valuable framework for management of utility asset information by more clearly defining the asset attributes that can be populated during specific stages of the business process, and which systems should have ownership and governance of those particular data attributes. A single point of truth spatial data warehouse provides one source where all data consumers in the utility can look for asset information. Adoption of this approach can provide significant improvement for the utility business processes and operations.