Using the CIM for integrating Field, Work, Control and Asset Management Systems at Scottish Power

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Abstract

Scottish Power's OASIS Program is responsible for replacing the IT systems which form the core of its Work Management, Asset Management, Real Time Control and Field Systems. To meet its architectural goals, the program needed to ensure the data used in its repositories and the services of its Service Oriented Architecture (SOA) would be semantically consistent. It is important that data be unambiguously and consistently shared among all users and systems. The first step for doing this was to develop an understanding of overall data requirements. This was accomplished through the creation of a Future Logical Data Model (FLDM) based on data requirements of business processes, legacy systems, new systems, reporting, and data stores. The FLDM was then used to evaluate fitness for purpose of the Common Information Model (CIM). Once it was determined that the CIM satisfactorily covered program data requirements, Scottish Power started following a model-driven integration process to define all information exchange with new applications and data stores.

After a brief overview of the business requirements and how they have driven the design of the enterprise integration, this paper shares program findings regarding adequacy of the CIM, how Scottish Power has and will continue to resolve gaps, and how the resulting enterprise semantic model is being used as a basis for information exchange and business intelligence.

Background

Scottish Power (SP) has:

- Two geographical areas with 3.43m customers;
- One transmission network, that being SP Transmission;
- 3,970 km transmission network
- Two distribution networks, one in Scotland and the other for Manweb;
- 107,900 km of distribution network, including 64,700 km of underground cables, 43,200 km of overhead line, and 83,800 substations.

In recent times, the approach to integration of systems at Scottish Power may be summarized as

SP Transmission
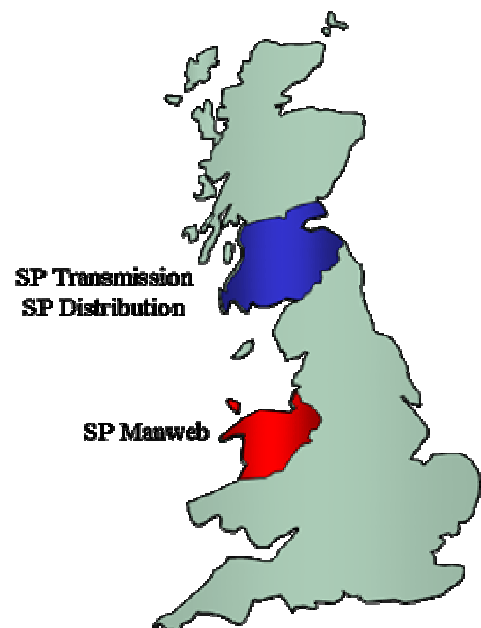SP Distribution

SP Manweb

Figure 1: Scottish Power's Service Territory

follows:

- It is commonplace to integrate systems with point to point technologies by copying batches of data between systems at the database level using different processes and technologies.
- The application integration architecture is more sophisticated than elementary typical integration architectures because the interface transactions are routed via a hub. However, the architecture is still essentially point to point with each interface being implemented as a dedicated mapping between a source application and a target application.
- Constellar Hub is the integration middleware supporting batch data transfer among many applications. It operates as a batch process. Changes to asset information, for example, accumulate in the master systems (e.g. in export tables) during the day and are transferred in batch, typically overnight.

This current integration approach is viewed as an unfortunate inhibitor to the achievement of business objectives because:

- The architecture is based on database-level integration, restricting the scope for coherent end-to-end business processes;
- There is no shared definition of key business terms, leading to inconsistent interpretations of meaning. An 'asset grouping' means something different to the engineering users to how the finance department use this term;
- There is too much complexity, with 211 systems and over 400 actual interfaces, leading to an increase in operational costs; and
- The interface architecture is closed, built on silos of data which are not easily shared.

A New Beginning for IT

Scottish Power's existing IT suite has been nearing the end of its useful life, having provided value to the business through a strategy of 'sweating the assets'. The need to update these IT assets presents Scottish Power with an opportunity to improve how IT supports the achievement of strategic as well as tactical business objectives. For example, ongoing Energy Networks re-organizations necessitate the delivery of new processes that are facilitated, not hindered, by IT systems. The development of revised business processes, enabled by new best of breed technology, would provide additional business benefits in the shape of performance improvements delivering improvements in regulatory performance. Accordingly, Scottish Power is implementing the OASIS Program, the scope of which is depicted in the following diagram. Preliminary plans were to implement this entire program in the near-term. However, after further analysis and consideration, Scottish Power has decided that it would prefer to implement this program in a series of small projects. To avoid producing more of the same ills that earlier integration efforts have suffered from, these 'autonomous' projects must be accomplished within the context of an 'integrated' integration infrastructure.
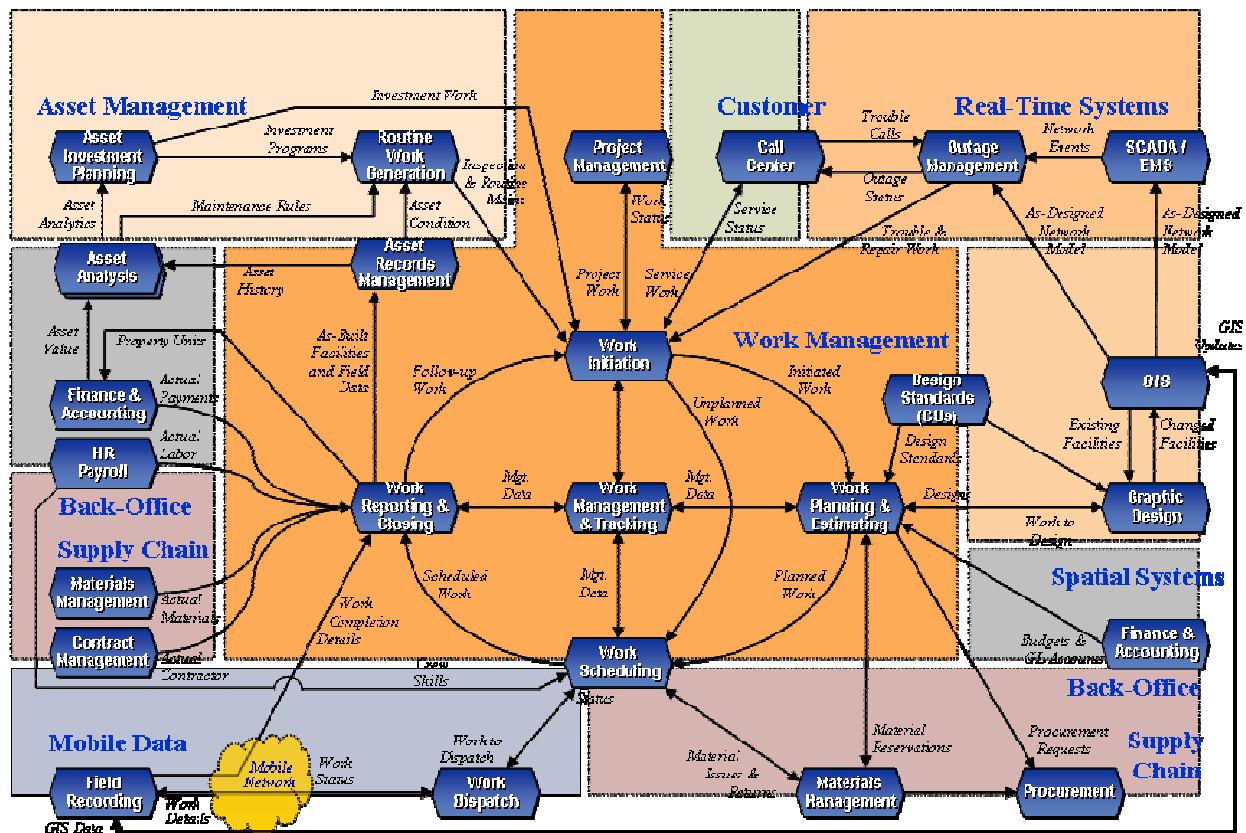
Figure 2: Scope overview of the functional integration within the OASIS Program

The key goals and principles underpinning the OASIS Program are outlined below:
- Meet the business goals.
- Provide a strategic architecture that is "future-proofed" to allow taking advantage of future advances in technology at minimum disruption and whole life cost.
- Use proven technologies and applications to minimize risk and ensure the delivery of functionality and associated business benefits.
- Prioritize the architecture by concentrating on areas that mitigate technical risks and/or where tangible business benefits can be achieved.
- Minimize disruptive impact on the business.
- Work from a proven reference model (e.g., the IEC 61968-1 Interface Reference Model) to guide product selection.
- Business processes will provide the primary design point for the application and data architecture. Integration requirements between systems should be driven from the business processes which they support. The outputs of the Business Reengineering effort will be used as inputs to a Model Driven Integration process, which provides a more holistic approach to system and application integration.
- Integration will be achieved by adopting a Service Oriented Architecture (SOA), which facilitates the delivery of application functionality as services to either end-

user applications or other services. The SOA will be based on Web Services standards where sufficiently proven and supported by an Enterprise Service Bus which provides the infrastructure for message exchange and mediation.

- Implement Web Services interfaces to applications in a consistent manner. Web Services development and deployment standards are critical to ensure a sufficient level of corporate-wide uniformity, as well as to increase development efficiency, allow for the ease of migration, and to position services for future technology developments.

- Open architecture and standards – the solution should be based on open standards, such as the IEC 61968 series of standards. This maximizes flexibility, allowing optimal use of the functionality of existing and future packages and systems and reducing integration and, hence, overall implementation costs.

'Integrating' IT's Integration Infrastructure
At the core of the integration strategy is the establishment of a 'semantic layer' that ensures all information is consistent as it is exchanged among disparate 'black box' applications, data stores and user interfaces.   This layer must be observed independent of which middleware technologies are used for each new interface. The middleware technologies being used for this program are summarized below and depicted in the following diagram:

- The existing Data Mirror Constellar Hub product set will be used where it is necessary to rewire existing batch interfaces to interact with new OASIS components. Each interface will be evaluated on an individual basis. Where new batch interfaces are required, ETL functionality will be used.

- Extract, Transform and Load (ETL) functionality is required to load the data warehouse and to assist with data migrations.

- The Enterprise Service Bus (ESB) uses a messaging infrastructure to connect systems. In this SOA, services are decoupled from each other and are independent of details of infrastructure. The majority of new interfaces between the new OASIS components for WAMS, Spatial Systems, Real-time Systems and Mobile are to be based on the IEC 61968 series of standards.
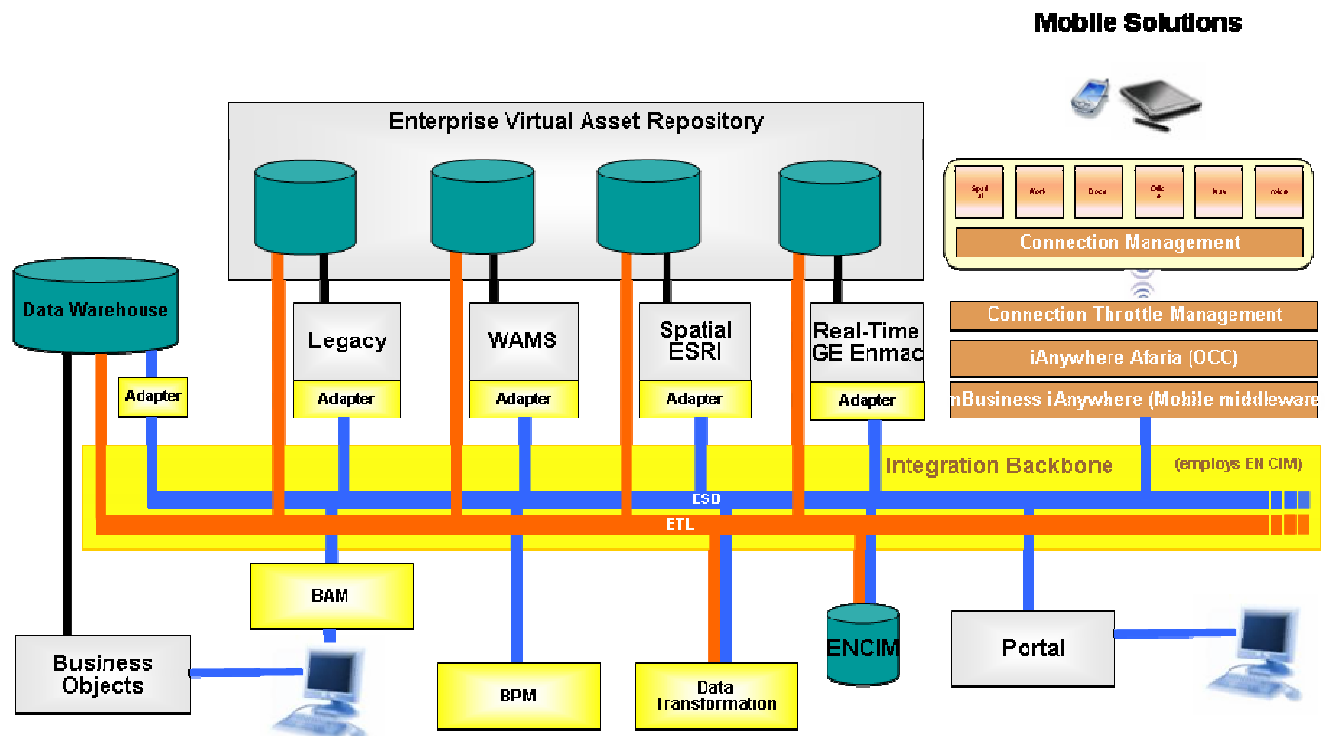
Figure 3: Primary Middleware Technologies of the Integration Infrastructure

The semantic layer mentioned above is accomplished through following the Model Driven Integration (MDI™) Methodology and tools provided by Xtensible Solutions. An overview of the MDI™ Methodology as applied at Scottish Power is shown in the following diagram. Having a quick look over this methodology, one will observe that it establishes data requirements from both a top-down (business process, business intelligence) and bottom-up (new systems, legacy systems, data stores, etc.) perspective. These data requirements then guide the development of an enterprise semantic model, referred to by Scottish Power as the "EN CIM" (Energy Networks Common Information Model). Once data is correctly modeled, the semantic model is used for defining service payloads and other forms of information exchange.

Rather than developing this model from scratch, Scottish Power prefers to leverage appropriate industry standard models – but only if they are fit for the purpose. An obvious candidate is the utility industry's Common Information Model (CIM), being developed and standardized by the International Electrotechnical Commission (IEC, which is the sister organization of the ISO, but is focused on electrical and electronics industries). However, rather than assuming the CIM would be appropriate for Scottish Power, it was decided to first establish requirements using entity relation diagrams in a Future Logical Data Model (FLDM). The FLDM could then be used to 'test' the adequacy of the CIM and/or other models before basing actual project work on these standard models.
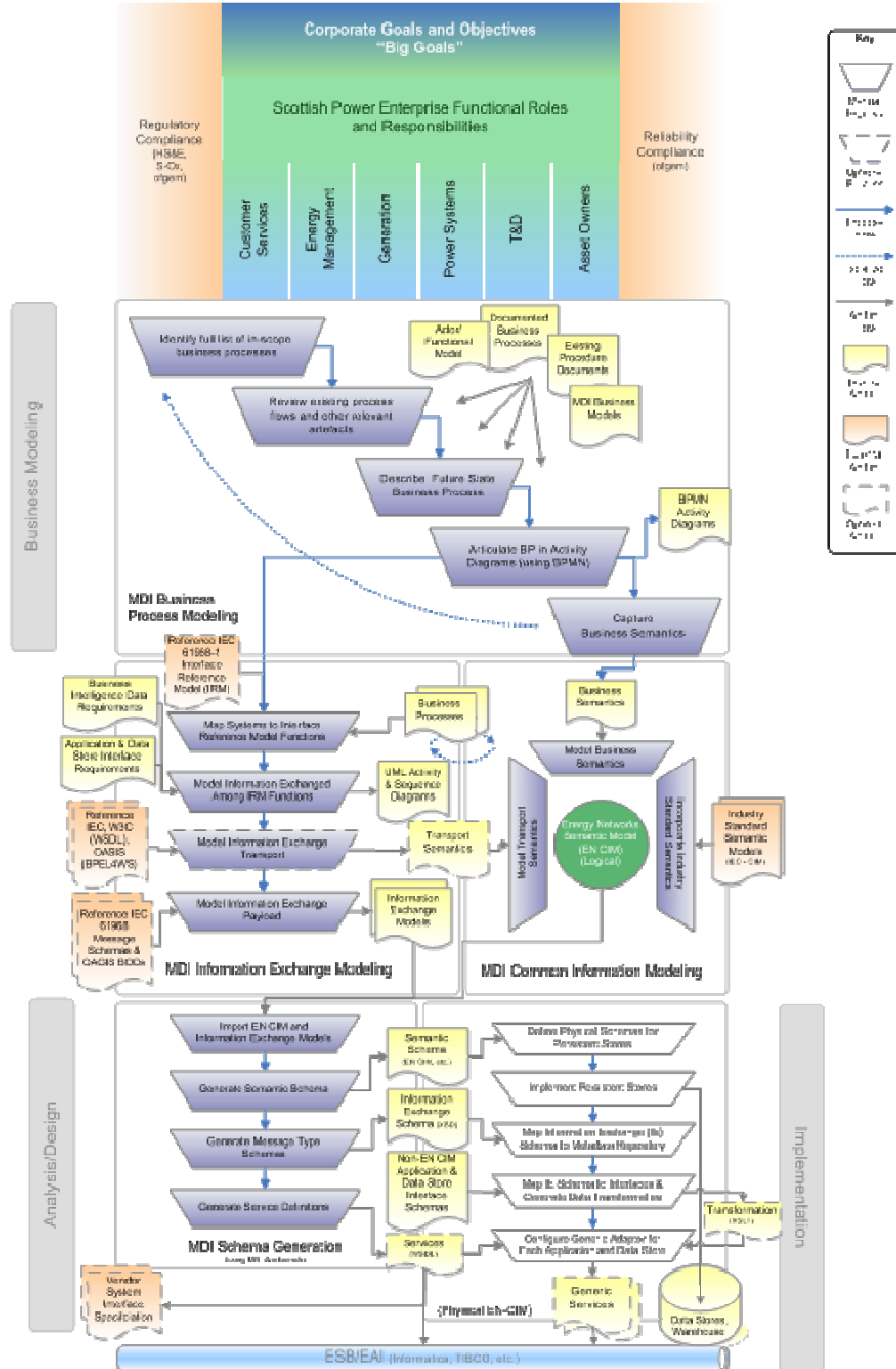
Figure 4: Overview of the Model-Driven Integration Methodology

So the FLDM was developed and represents the best understanding of the data required in the OASIS Program. This allows a technology- and application-independent view of the data to be created, unencumbered by current and possible future constraints imposed by application software. This data model provides a framework for an organized inventory of data needs. It also plays a role in defining the mastership or prime application responsibility for the various elements of data.
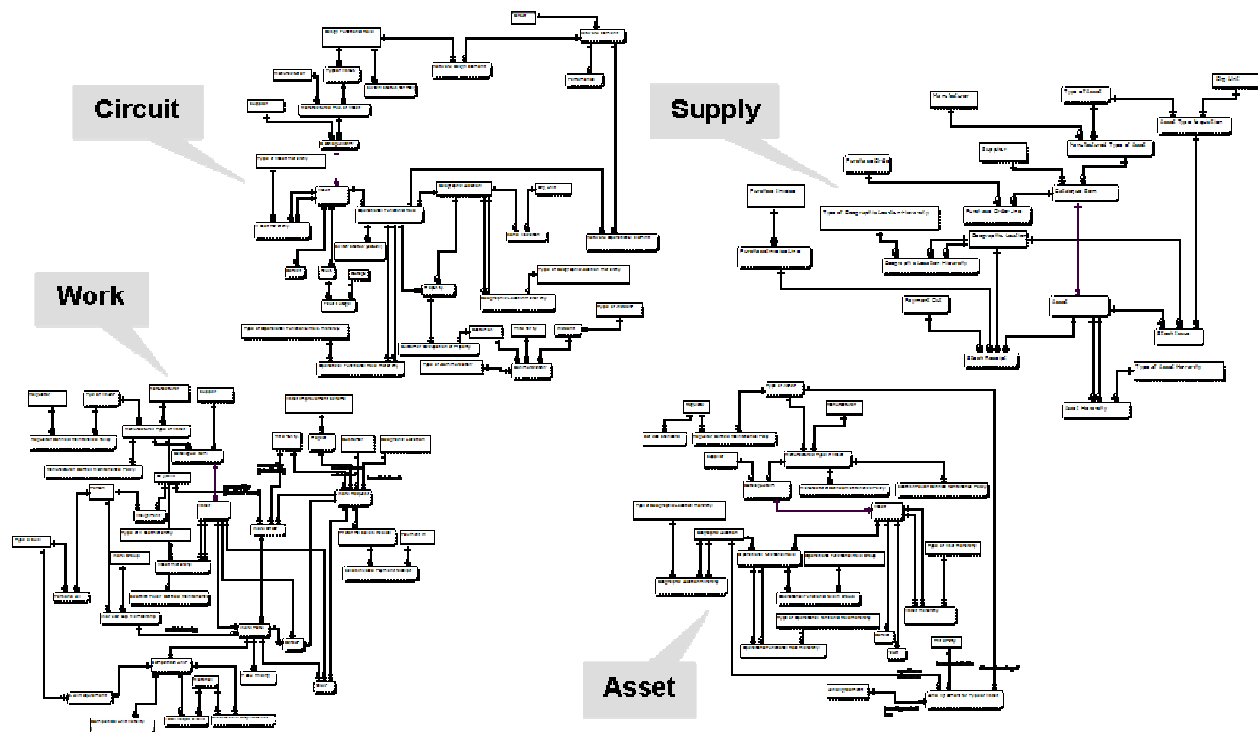
Figure 5: Overview of Future Logical Data Model (FLDM)

As shown in the following table, once the FLDM was completed, entities of the FLDM were mapped to objects of the CIM.   Well over 90% of the objects mapped directly to existing CIM objects. As Scottish Power prefers to have a standards-based solution, necessary CIM extensions were coordinated with IEC TC57 Working Group 14 (i.e., the working group responsible for the IEC 61968 series of standards). As a result, the latest release of the CIM from the IEC (release based on CIM iec61970CIM10r04_iec61968CIM8) includes all necessary extensions and therefore covers 100% of the data needs identified by the FLDM. [1]

	Future LDM Entity	Provisional CIM Class Mapping (CIM 10r7)	Subject Area			
			Asset	Circuit	Supply	Work
1	Asset	61968::Assets::AssetBasics::Asset	✓	✓	✓	✓
2	Asset Hierarchy	61968::Assets::AssetBasics::Asset (0..n) to (0..n) Asset recursive association	✓	✓	✓	✓
3	Asset Improvement Scheme	61968::Work::WorkBilling::Project				✓
4	Asset Type Requisition	61968::Work::WorkScheduler::UtilityRequisition			✓	
5	Assignment	61968::Core2::TopLevel::Assignment (Added to CIM 10r8)				✓
6	Catalogue Item	61968::Assets::AssetBasics::AssetModel (0..n) to (0..n) Organisation (via specialisation of Document) [via DocOrgRole with roleType attribute set to 'Manufacturer'] plus same association [via DocOrgRole with roleType attribute set to 'Supplier'] *(May be replaced by Catalogisation class in CIM 10r8)*	✓	✓	✓	✓
7	Circuit	*Superceded by 'Operation Functional Role Hierarchy' description*		✓		
8	Communication	61968::Documentation::TroubleTickets::TroubleTicket		✓		
9	Compatible Unit	61968::Work::WorkDesign::CompatibleUnit				✓
10	Compatible Unit Activity	61968::Work::WorkInspectionMaintenance::Procedure (0..n) to (0..n) 61968::Work::WorkDesign::CompatibleUnit *(fixed association added to CIM 10r8)*				✓
11	Consumable Requirement	61968::Work::WorkStandards::CUMaterialItem				✓
12	Customer	61968::Core2::TopLevel::Organisation [with OrgOrgRole] (1) to (0..1) CustomerData *(Added to CIM 10r8)*		✓		✓
13	Customer Occupation of Property	61968::Core2::TopLevel::Organisation (0..n) to (0..n) 61968::Core2::Locations::AssetProperty *(Added to CIM 10r8)*		✓		
14	Defect	61968::Work::WorkInspectionMaintenance::InspectionDataSet aggregated from DataSet from which DiagnosisDataSet is also aggregated	✓	✓		✓
15	Design Functional Role	61970::Core::PowerSystemResource		✓		
16	Fault	61968::Assets::AssetBasics::FailureEvent	✓	✓		✓
17	Fault Outage	61968::Documentation::TroubleTickets::FailureEvent specialisation of ActivityRecord specialisation of Document of which OutageRecord is a specialisation. Recursive association on Document to associate any two Document specialisations.		✓		
18	Geographic Location	61968::Core2::Locations::Location (0..1) to (n) Asset Location associated with (0..n) CoordinatePair	✓	✓	✓	✓
19	Geographic Location Hierarchy	61968::Core2::Locations::Location (0..1) to (0..1) Location *(Recursive association changed to be (0..n) to (0..n) in CIM 10r8)*	✓	✓	✓	
20	Incident	61968::Documentation::Outages::IncidentRecord with 'IsPlanned' attribute set to False *(Added to CIM 10r8)*		✓		
21	Land Agreement	*See 'Land Agreement for Type of Asset' description*	✓			

Figure 6: A Snippet from the FLDM-CIM Map

Examples of the FLDM-CIM mapping are depicted in the adjacent diagram for a use case entitled 'Carry out maintenance on Substation equipment.' This use case involves three primary steps: ensure equipment isolated; maintain equipment; and take appropriate measurements and readings.

As the program progresses and details are fleshed out with the vendors, additional data requirements will be found, some of which may not be in the current standard CIM. However, this exercise demonstrated that the overall structure and depth of the CIM is fit for the purpose of enterprise-wide T&D application integration, and certainly will suffice for the data integration needs identified for the OASIS program. Accordingly, Scottish
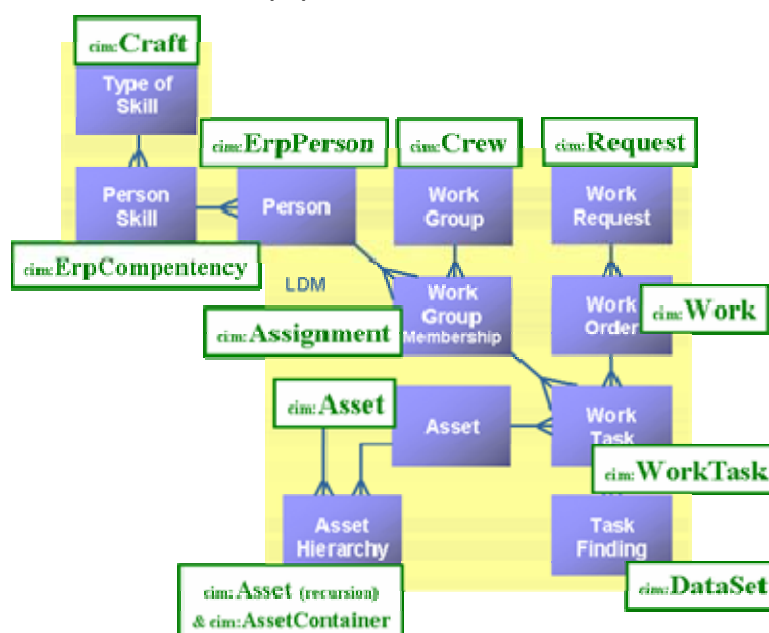

Figure 7: Example FLDM-CIM Mapping for a Use Case

Power confirmed its preliminary plan to base its services and their payloads on the IEC 61968 series of standards, using MDI™ to identify and perform extensions to the CIM and message payload schemas as needed. Though too small to read any details, it is interesting to see Scottish Power's current EN CIM in the following diagram. Note that only the objects that are mapped to the four subject areas of the FLDM are shown.
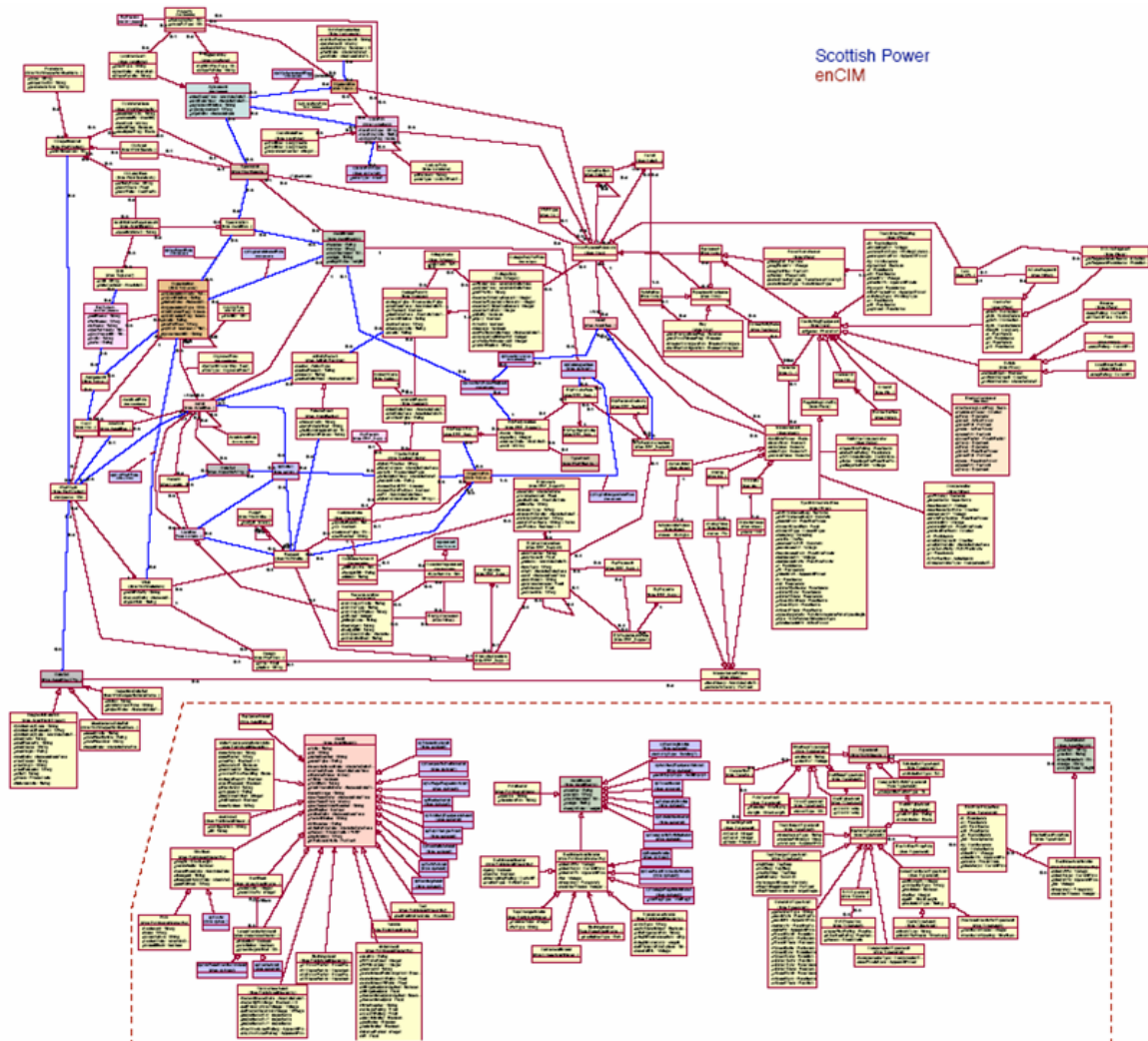

Figure 8: Overview of Scottish Power's EN CIM

Conclusion

Scottish Power needed to find a way for autonomous IT projects to be able to efficiently accomplish their goals without sacrificing overarching corporate goals. Key goals, principles and considerations underpinning the design of the integration infrastructure were developed with this in mind. Scottish Power has now defined a methodology, tools, standards and a governance structure to enable independent projects to do their bidding while contributing to the great good. Now integration can be performed in step with business needs, knowing that each increment of work fits into an integrated whole.

Now focusing on the subject matter of this paper, benefits are broken down into three categories. First, the benefits of a Scottish Power Enterprise Semantic Model (EN CIM) include:
- Consistent Integration of Systems and Processes
- Reduced Risk
- Reduced Integration Complexity
- Reduced Interface Support and Maintenance
- More Consistent Business Communications
- Improved Integration of New and Upgraded Systems
- Reduced System and Business Process Dependencies

Second, benefits of Model Driven Integration include:
- Repeatable Methodology Resulting in Consistent:
  - Business Process Models
  - Common Information Models (EN CIM)
  - Information Exchange Models Based on the EN CIM
- Traceability to/from Corporate Goals and Objectives
- An Open, Technology-Independent Approach
  - Supports Various Approaches to Implementation
  - Supports Evolution of Runtime Platforms
  - Approach Incrementally, use Pilot Projects to Establish Processes and Semantics, then Apply Across Enterprise As Able
- Reuse of Models, Interface Definitions, other Artefacts
- Leverage Industry Standard Semantic Models, i.e. the IEC CIM

Finally, benefits of the IEC CIM include:
- Industry standard model
- Maintain consistency with industry direction
- Positions Scottish Power to benefit from an evolving marketplace of products supporting CIM
- Leverage standards-based tools and technologies
- Serves as starting point and guide for defining Scottish Power's semantic model
- Scottish Power semantics expressed consistent with industry standards

References
[1] Presentations and committee drafts from IEC TC57 Working Groups 13, 14, 16, and 19 (refer to http://www.iec.ch and http://www.ucausersgroup.org), 2006.