

Forward Capacity Market Technology Solution Overview

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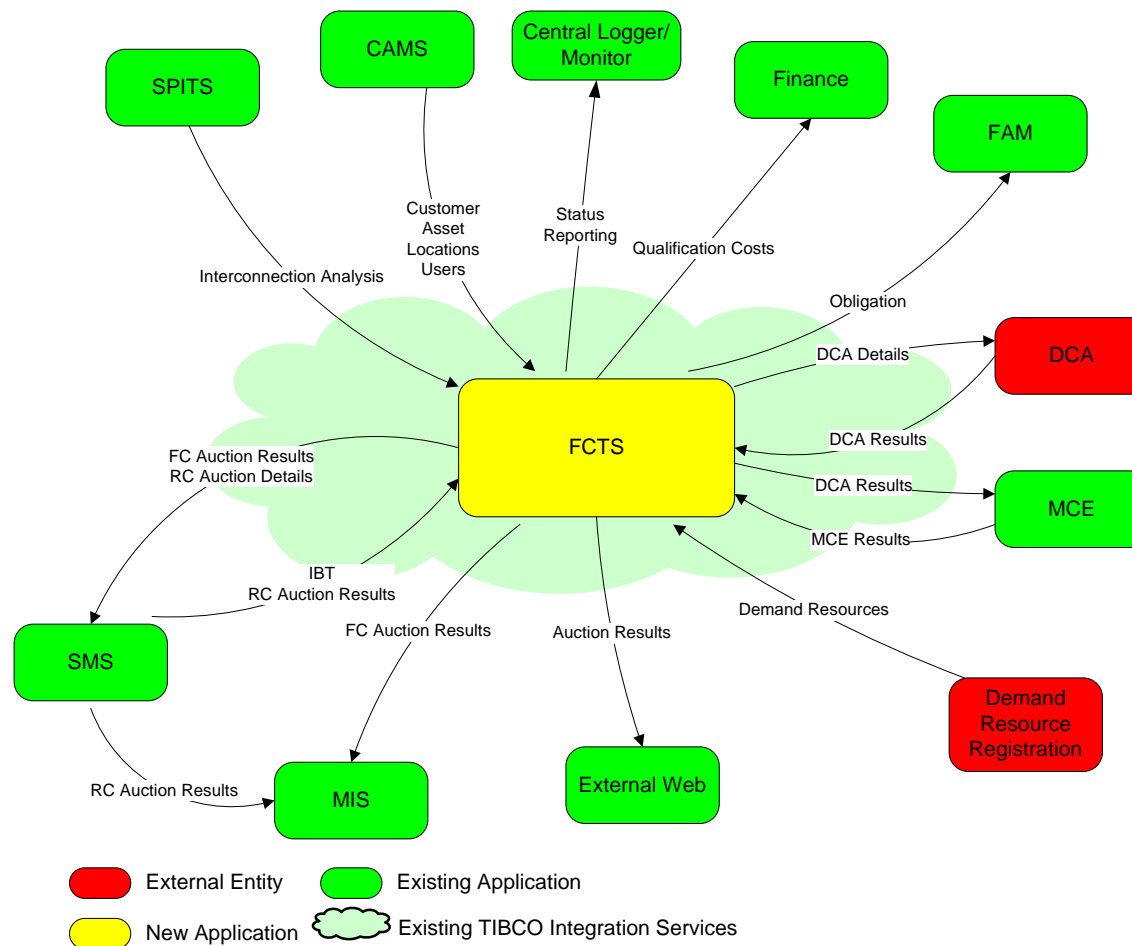
Forward Capacity Market - Introduction

- **Objective:** Procure enough capacity to meet New England's forecasted demand and reserve requirements three years in the future.
- **Procurement Method:** Select a portfolio of Supply and Demand Resources through a competitive Descending Clock Auction (**DCA**) process.

Forward Capacity Market Life Cycle

- **Qualification Period:** Determine which Resource projects can be submitted into the auction. ISO conducts reliability analysis on applications in deciding to approve/reject.
- **Planning/Construction Period:** Project Sponsors install/construct new Resources or upgrade existing resources to fulfill capacity obligations acquired via the DCA.
- **Commitment Period:** Resources are available to meet energy requirements and FCM payments begin.
- ***Total Life Cycle Duration could be up to 4 years (from SOI to go live)***

FCM System Interactions



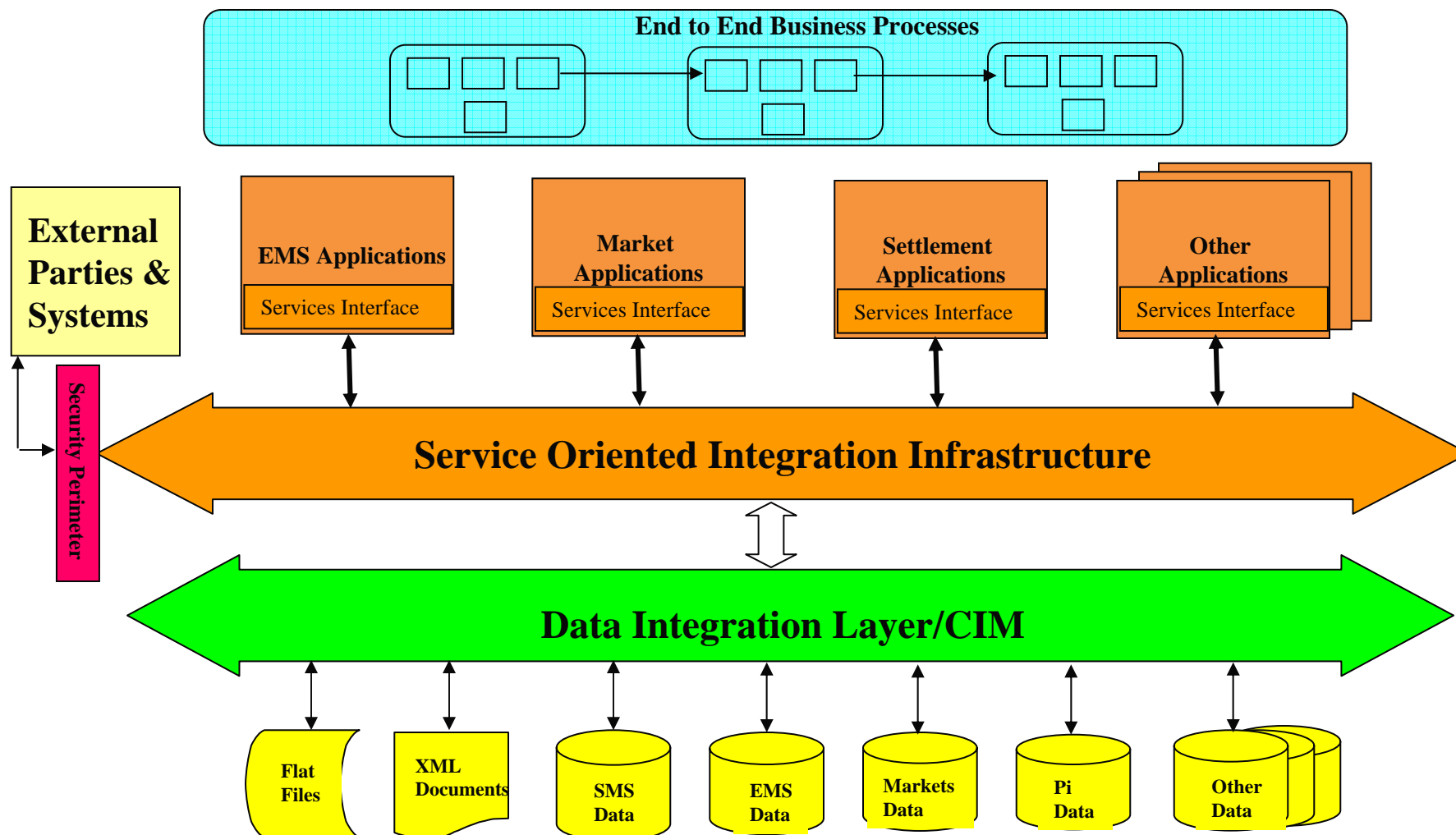
FCM System Solution

- Implemented on ISO-NE's SOA Integration Framework
- Adheres to ISO-NE's Enterprise Architecture standards

ISO-NE Enterprise Architecture Model



ISO-NE Service Oriented Architecture Framework



Challenges Inherent in the FCM

- Relatively short duration from SOI to DCA Auction
- Labor intensive qualification process (e.g. reliability studies)
- Mix of resources (demand, supply, intermittent generation, imports)
- A single month could have 3 reconfiguration auctions and one DCA running concurrently
- New Generation Projects represent long running “workflow transactions” within the tracking system
- Significant dependence on 3rd party (DCA)
- Integer non-linear optimization problem with equilibrium constraints
- No “off the shelf” solution

Core Ingredients in the FCM Solution

- Forward Capacity Tracking System (FCTS)
- Descending Clock Auction System (DCA)
- Market Clearing Engine (MCE)
- Common Information Model (ISO-NE CIM)
- Service Oriented Infrastructure
- Central Logging and Business Activity Monitoring (BAM)

FCTS

- Serves as the central hub and coordinator of FCM activity
- “System of Record” for a large portion of FCM data
- Has externally facing Web UI to handle most FCM related activity
- Manages the Qualification Process, including:
 - multi-system workflow and integration activities across system planning, customer and asset management and financial systems
- New Generator Project Tracking (up to 3 year period)
- Coordinate interactions with external Auctioneer software
- Coordinate interactions with Market Clearing Engine software
- Publishing of Auction Outcome and other Auction Data

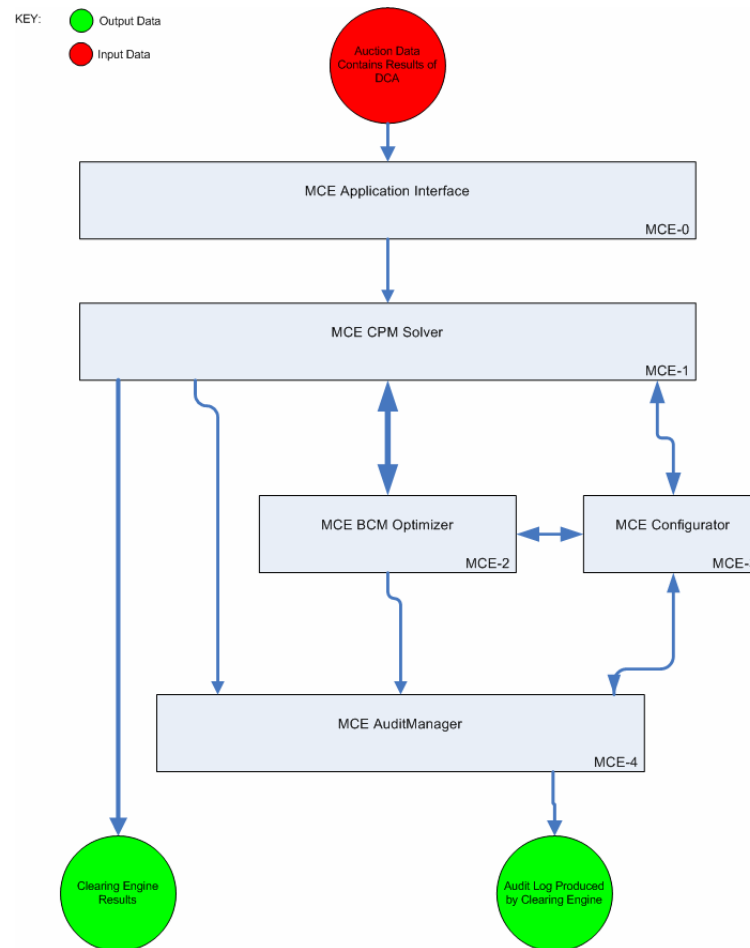
DCA Software

- Developed by 3rd party (Power Auctions)
- Auction conducted by same 3rd party vendor
- Multi-Round Dynamic Auction (up to 8 rounds per day)
- Price drops each round
- Auction Closes when Supply no longer exceeds Demand or Floor price reached

Market Clearing Engine

- Designed to minimize system wide Consumer Payment while respecting capacity requirements, maximum capacity limit , capacity transfer limits over external interfaces, over-buying constraints in import-constrained areas, and other system wide conditions
- The Clearing Price is the result of solving a Consumer Payment Minimization problem (“CPM”)
- Provided as a “Service” via the SOA infrastructure
- All input/output data is ISO-NE CIM compliant in XML
- Developed by ISONE in Java using commercial optimizer (CPLEX)

MCE Architecture



ISO-NE CIM

- ISO-NE managed/maintained Common Information Model
- “Lingua Franca” for the SOA integration infrastructure
- Based on existing internal vocabulary
- Defines data element names, type information and semantics/usage
- Implements IRC/ITC standards for BAM status reporting
- Modular design based on “natural” data groupings within ISO-NE (e.g. Customer data, Asset Data, FCM data, etc.)
- XML compliant

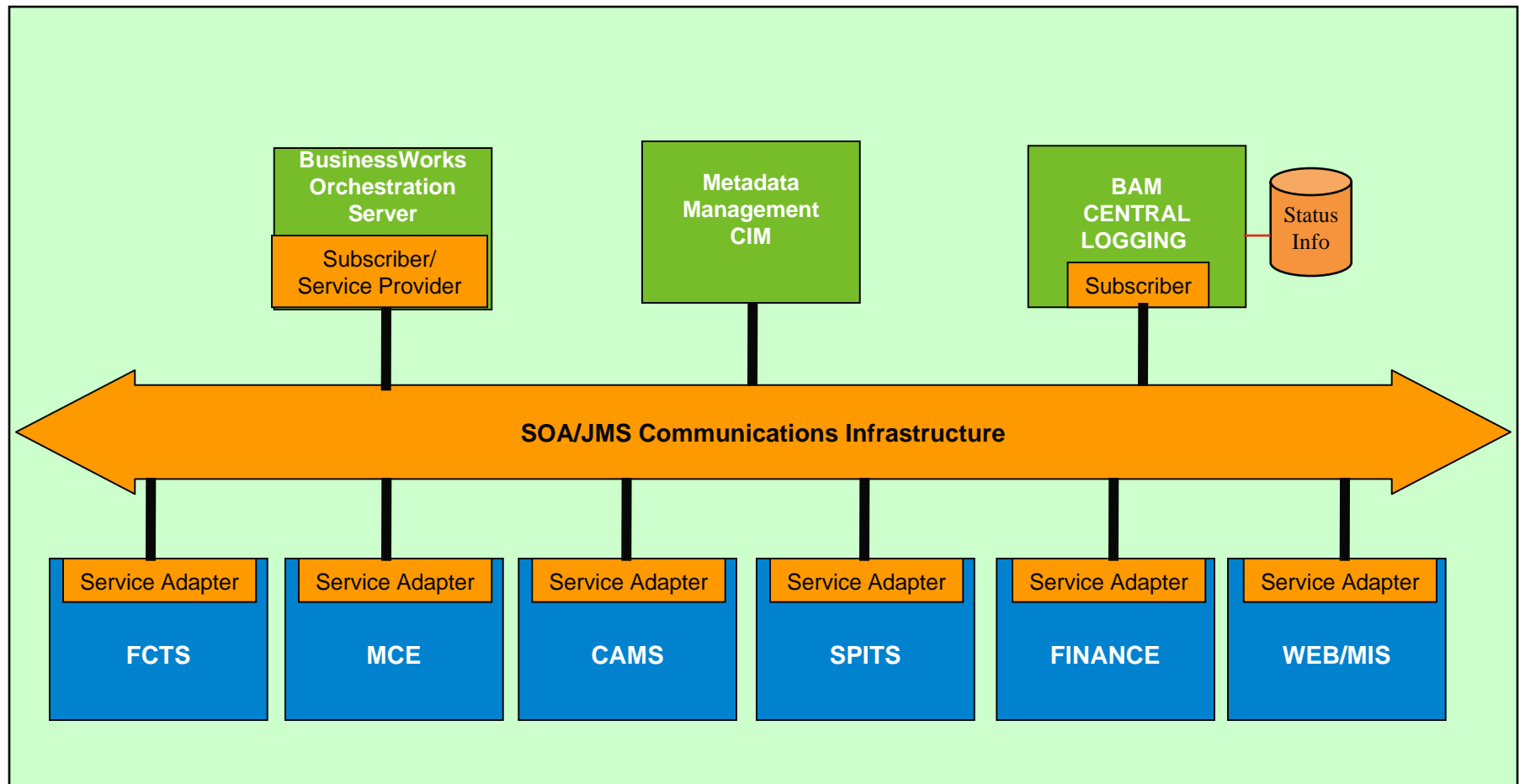
SOA Infrastructure

- Built on high availability JMS software (TIBCO EMS)
- Supports Request/Reply and Publish/Subscribe messaging patterns
- Implements an Orchestration Server to ensure Business Process level transactional integrity and manage multi-system interactions
- Uses TIBCO BusinessWorks for Orchestration and Application Adapter development/implementation
- Reports all Business Process and Adapter activity

Central Logger and BAM

- Captures all status messages sent over the SOA infrastructure
- Utilizes Oracle database for persistent storage
- Capture mechanism built with TIBCO BusinessWorks and JMS (EMS)
- Administrator interface (dashboard) built using Struts, JSP, Tomcat, Java and Tibco JMS
- Displays status data in Business Process views as well as end-to-end transactional views
- Main Dashboard for “instant insight” of Business Process Activities and processing status
- Monitors application heartbeats/healthchecks
- Implements IRC/ITC BAM status reporting standard

ISO-NE Internal FCM Deployment



Summary

- Internal FCM Solution was built entirely on ISO-NE Enterprise Architecture Standards and SOA Framework
- Decoupled design using an Orchestration Server/CIM has proven effective at:
 - isolating “integration development activities” from other development activities enabling orthogonal development
 - ensuring transactional integrity and data quality across application interactions/business processes
 - providing a high degree of software reuse and consistency
- Long running transactions (up to 4 years in length) are managed using workflow techniques in a central tracking system (FCTS)
- First FCM Auction took place February 4-6, 2008 for 2010 commitment period and consisted of eight rounds of bidding