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USAGE OF CIM IN SYSTEM OPERATIONS IN INDIA

by

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(IN)

SUMMARY

Utilities are having a wide deployment of various software systems for real-time monitoring, optimized operations, and for achieving various business functions. Considering these software systems, there are large numbers of information exchange scenarios and use cases. They exist within inter utility environment as well as in intra utility environment. There are multiple software systems and components involved in these information exchange scenarios. They are procured from different vendors at different point in time. Often these information exchanges demand very complex integration projects with high cost of execution, which either results in a case to case custom integration using ad-hoc methods or a no integration scenario creating information silos. With a case to case custom integration the number of integration adapters which are needed will increase drastically especially when number of applications and integration requirement increases.

Given the enormity, complexity and technological up gradation of the Indian power system, applying Common Information Model (IEC-61970, IEC-61968 and IEC-62325) and thence, a set of interface specification is essential. With above context, in this paper usage of CIM in system operations at a load dispatch centre in India is discussed.

The present scenario of system operations in India is characterized by lack of standard inter-application protocol, no application integration bus, applications exchange data by point-to-point interconnections, ad-hoc information exchange formats based on online forms, CSV, Excel, flat-files, emails or even PDF files, and modification / expansion is difficult due to tight coupling of applications.

The requisite list of application use cases identifying information exchanges where CIM driven integration has potential to be implemented are presented. A predominant application use case – scheduling information exchange at regional load dispatch centre is analyzed further for adoption of CIM. The As-Is adoption feasibility is analyzed and required extension classes to CIM, for adoption in India, is presented.

KEYWORDS

CIM, Availability Based Tariff

1. INTRODUCTION

Availability Based Tariff comprises of three components: (a) capacity charge, towards reimbursement of the fixed cost of the plant, linked to the plant's declared capacity to supply MWs, (b) energy charge, to reimburse the fuel cost for scheduled generation, and (c) Unscheduled Interchange - a payment for deviations from schedule, at a rate dependent on system conditions. The last component would be negative (indicating a payment by the generator for the deviation) in case the power plant is delivering less power than scheduled and positive in case the power plant is delivering more power than scheduled when frequency is low. For a distribution company, Unscheduled Interchange charges will be corresponding to its drawal versus schedule. In addition to this, penalty (in geometric progression) will be levied for Mis-Declaration; Incentive will be given for achieving PLF greater than the target at a rate notified by the regulatory commission. In short; For Load Dispatch Centre; Energy Scheduling, Energy Accounting, and Maintaining UI Pool. For Generating Stations; Penalty for Mis-declaration in geometric progression of two days fixed charges, Realization of capacity charges in prorata basis with respect to achieved availability being lesser than the notified target availability, Incentives at notified rate for achieving more than the target PLF, Negative UI charges at notified UI rate corresponding to frequency when dispatch is less than the schedule, Positive UI charges at notified UI rate corresponding to frequency when dispatch is more than the schedule, Gaming constraints at 105% in a block and 101% in a day and UI rate capping, Penalty for consuming more than the auxiliary consumption limit. For Distribution Companies; Negative Unscheduled Interchange Charges for actual drawal more than the drawal schedule, and Positive Unscheduled Interchange Charges for actual drawal more than the drawal schedule. This paper analyses the adaptability of CIM for modeling ABT mechanism prevalent in Indian Power Sector. Some of the major activities carried out in this work are identification of Information exchanges in ABT regime, modeling of energy scheduling and energy accounting under ABT, and modeling of ABT meter data.

2. COMMON INFORMATION MODEL

CIM is an object-oriented model, describing an organization's computing and networking environments. All managed elements are positioned within CIM, clarifying semantics, streamlining integration and reducing costs. CIM facilitates data reuse, delivering consistency of information across products and releases of products. Reuse can be achieved through CIM. Introduction of CIM would change the traditional point-point model to a hub-spoke model with CIM placed at the hub. If the data definitions change for one application spoke (or a new application is added in to the enterprise), only the interface mappings that corresponds to that application would be changed (created) and rest all interfaces remains the same. CIM had been incorporated by IEC vide IEC TC 57 – IEC 61970, IEC 61968 and IEC 62325. CIM consists of three major standards IEC 61970 (Basic Power System components), IEC 61968 (Distribution Management System) and IEC 62325 (Energy Scheduling, Financial, Reservation and Market Operations). For modeling ABT, classes from all the three major packages depicted in Fig. 1 are used. For adapting CIM to model ABT, a thorough understanding of the various perspectives of ABT mechanism should be understood. Chapter 4 explains the ABT perspectives.

3. ABT ENERGY SCHEDULING AND CIM

3.1. ENERGY SCHEDULING INFORMATION EXCHANGE

Load Dispatch Centre exchanges various types of scheduling information with stake holders. The message types are depicted in Figure 1. To understand the message types, basically the activities involved in ABT scheduling process needs to be understood. The process starts with the calculation of day ahead capacity by generating stations. The generating stations declare the foreseen capacity to load dispatch centre. The load dispatch centre applies entitlement percentage and declares the entitlement power to distribution companies. Based on it, the distribution companies declare their requirement to load dispatch centre. Based on the declarations by generating stations and distribution companies, and merit order list, the load dispatch centre prepares the dispatch schedule and drawal schedule of generating stations and distribution companies correspondingly

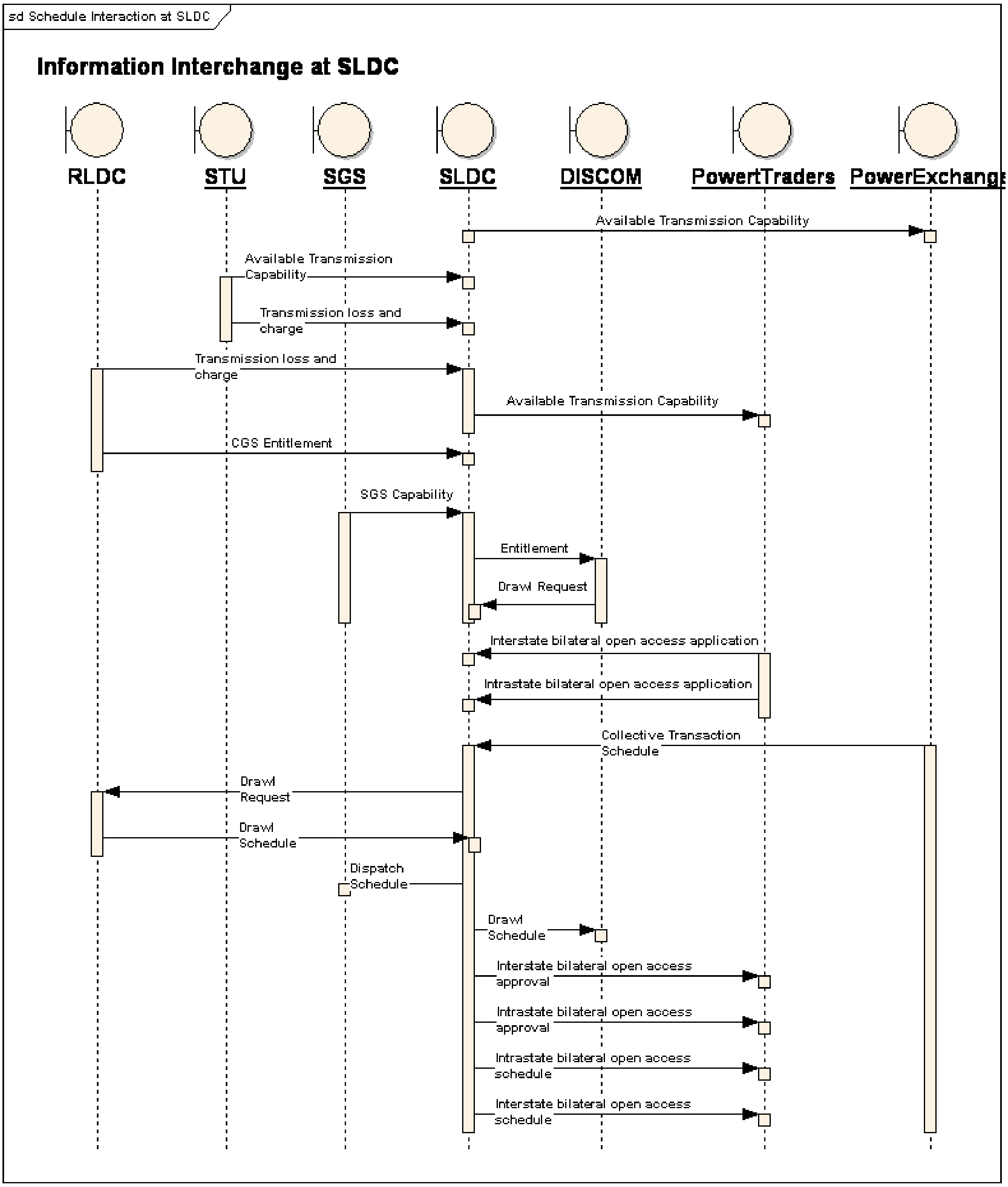

Figure 1 Scheduling Information exchanged between stakeholders

3.2. ABT ENERGY SCHEDULING MECHANISM

The above factors had been considered in modeling ABT in CIM and the model is presented in this work.

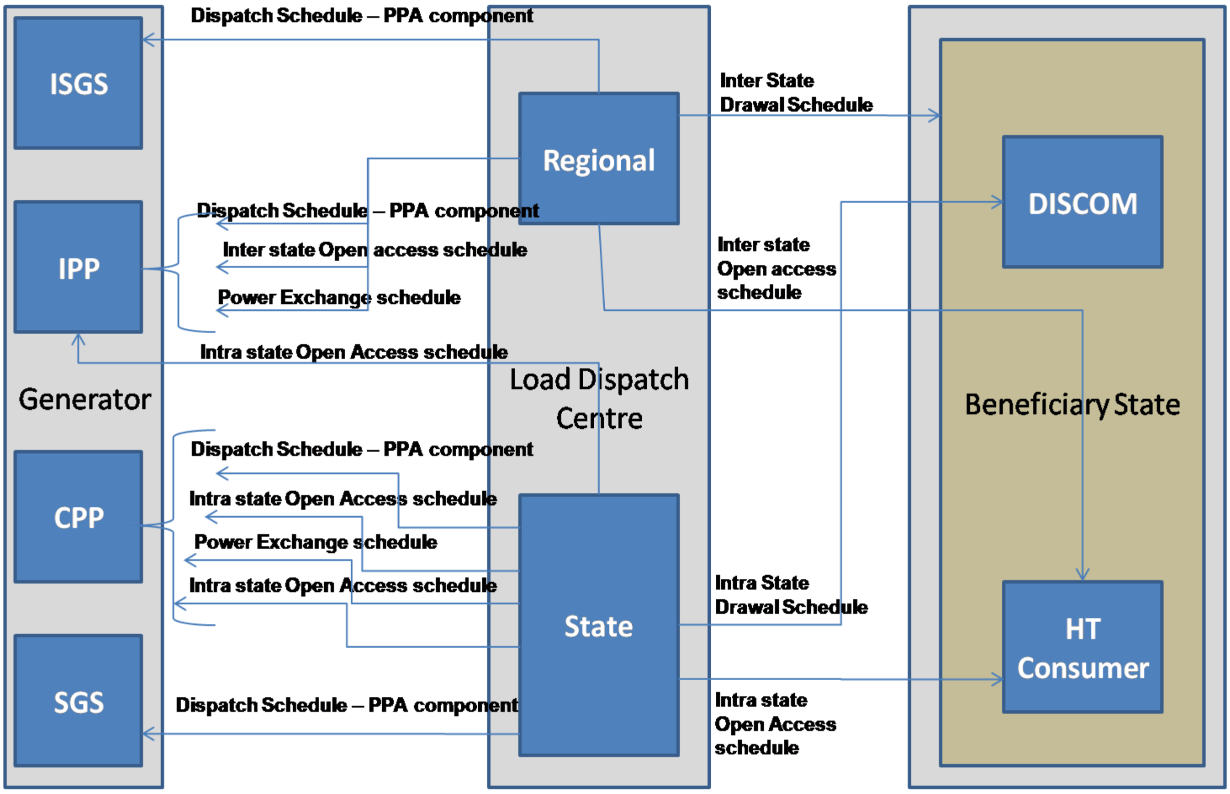

Figure 2 ABT Energy Scheduling Mechanism

While implementing ABT, the perspective changes with respect to where it is implemented. Modeling of Availability Based Tariff mechanism at ISO or RTO periphery includes Energy Scheduling, Energy Accounting, Balancing and Settlement. Generating stations of capacity 20MW and above, Distribution companies, and HT industries shall comply with ABT mechanism. Energy scheduling shall be based on merit order dispatch, power purchase agreements and entitlements. Energy Accounting and balancing and settlement is done based on entitlements, gaming constraints, power purchase agreements, contract demand and open access agreements. The key factors that need to be considered while modeling ABT are the extent of applicability of ABT on different type of utilities based on the nature of the product chosen. When energy product is chosen, all the three components of ABT namely capacity charges, energy charges and Unscheduled Interchange charges are applicable. When open access product or power exchange product is chosen only unscheduled interchange charges are applicable. Modeling of Availability Based Tariff mechanism at generation periphery includes capacity declaration, merit order dispatch, AGC, capacity charges realization, PLF incentive realization, and +ve UI charges maximization. Modeling of Availability Based Tariff mechanism at distribution periphery includes requirement declaration based on load forecast, entitlement, and +ve UI charges maximization. While modeling the metering aspect of ABT, a key factor to be considered is the Multiplication Factor which shall be applied at the receiving end (control centre) of automated meter reading application. Substation personnel change CT/PT which affects the multiplication factor. The changes in CT/PT and hence the multiplication factor needs to be informed to the load dispatch centre. Also on replacing the meter, information has to be given to load dispatch centre. This information exchange shall be interoperable. The scope includes ABT energy scheduling and ABT energy accounting carried out by a load dispatch centre and modeling them in CIM.

Capability is declared by generating stations at the interface point. The declared capacity is sent to the SLDC as information. Based on the allocation percentage, load dispatch centre calculates the entitlement of each beneficiary at its interface point with the transmission system after subtracting the transmission losses. The present CIM version does not have class for representing the entitlement percentage. Beneficiaries send requirement to load dispatch centre based on their entitlement and load forecasting. The Generating Stations declare their capacity at their interface point with the transmission system. The Distribution companies submit their requirement at the interface point with the transmission system. Based on the entitlement percentage, transmission loss profile and merit order stack, load dispatch centre prepares the dispatch schedule and drawal schedule.

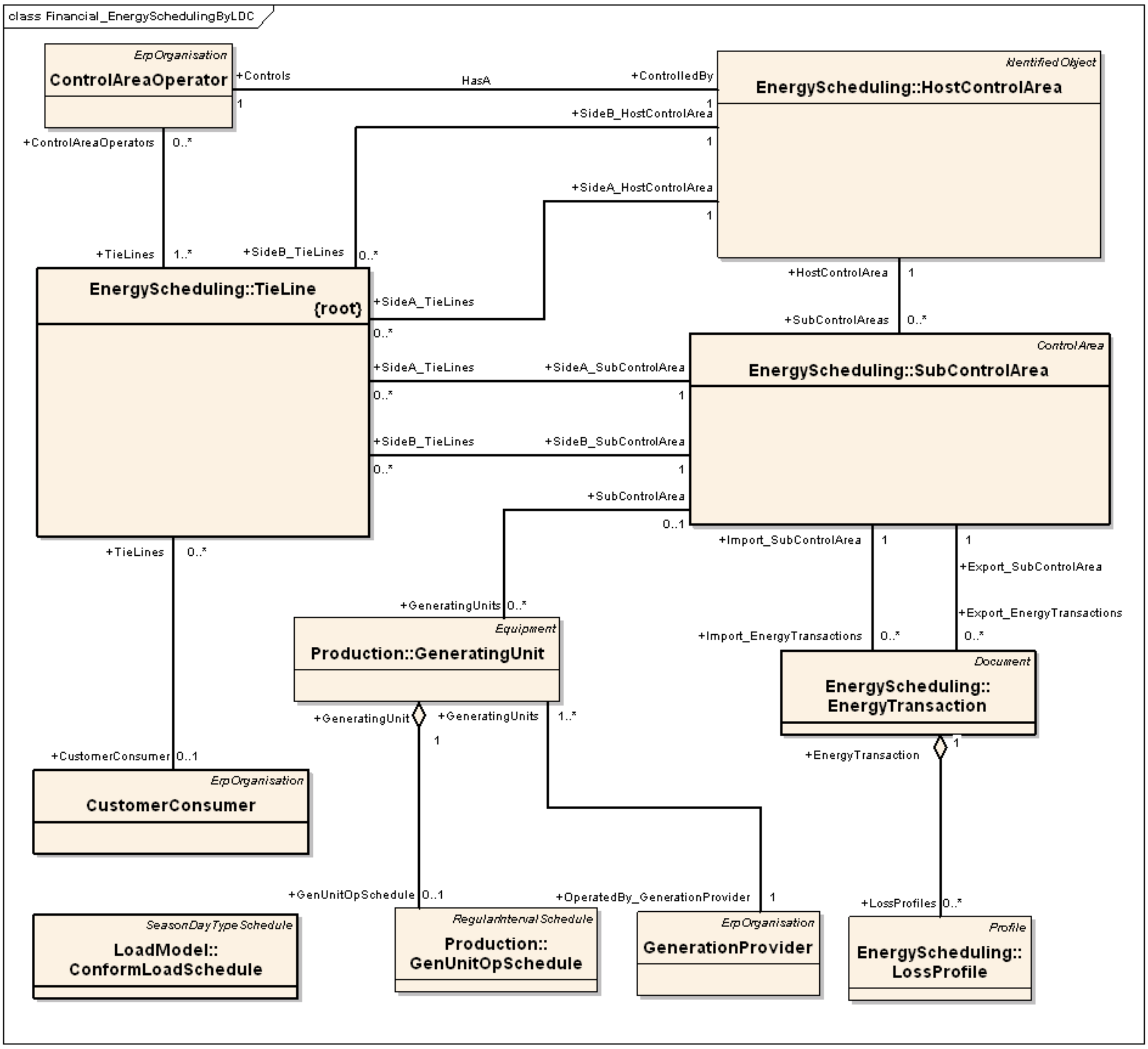

Figure 3 Energy Scheduling by Load Dispatch Centre

In Figure 3Figure 3, the classes involved in modeling the ABT energy scheduling mechanism in CIM are depicted. The classes depict a logical representation; the intricacies of the associations involved are not shown in this figure.

The class ***EnergyScheduling::SubControlArea*** is central to modeling energy scheduling. It is defined as "An area defined for the purpose of tracking interchange with surrounding areas via tie points". It is the boundary within which export and import energy transactions take place between ***Production::GeneratingUnit*** and ***ErpOrganisation::CustomerConsumer.*** The interchange area may operate as the control area. Such an associated control area is the ***HostControlArea*** which is controlled by ***ControlAreaOperator.*** The ***SubControlArea*** is bounded by metered points at the A side or B side of ***TieLine.*** The ***GeneratingUnit*** provides capability declaration using ***GenUnitOpSchedule.*** The Beneficiary modeled as

CustomerConsumer submits it drawal requisition using ***LoadModel::ConformLoadSchedule.*** The ***ControlAreaOperator*** *(known as Load Dispatch Centre)* utilizes ***EnergyTransaction*** to specify the dispatch and drawal schedule for energy transfers between interchange areas that are necessary to satisfy the associated interchange transaction. The transmission loss is modeled using class ***EnergyScheduling::LossProfile.*** The attributes and associations of these classes are explianed in section 5.

4. ABT ENERGY ACCOUNTING AND CIM

4.1. ENERGY ACCOUNTING AND CHARGES INFORMATION EXCHANGE

SLDC exchanges energy accounting and charges information with stake holders as depicted in Figure 4. Load Dispatch Centre exchanges/ publishes information in two broad heads – State Energy Account & Charges and UI Pool Account. Representation of this information in CIM is presented here.

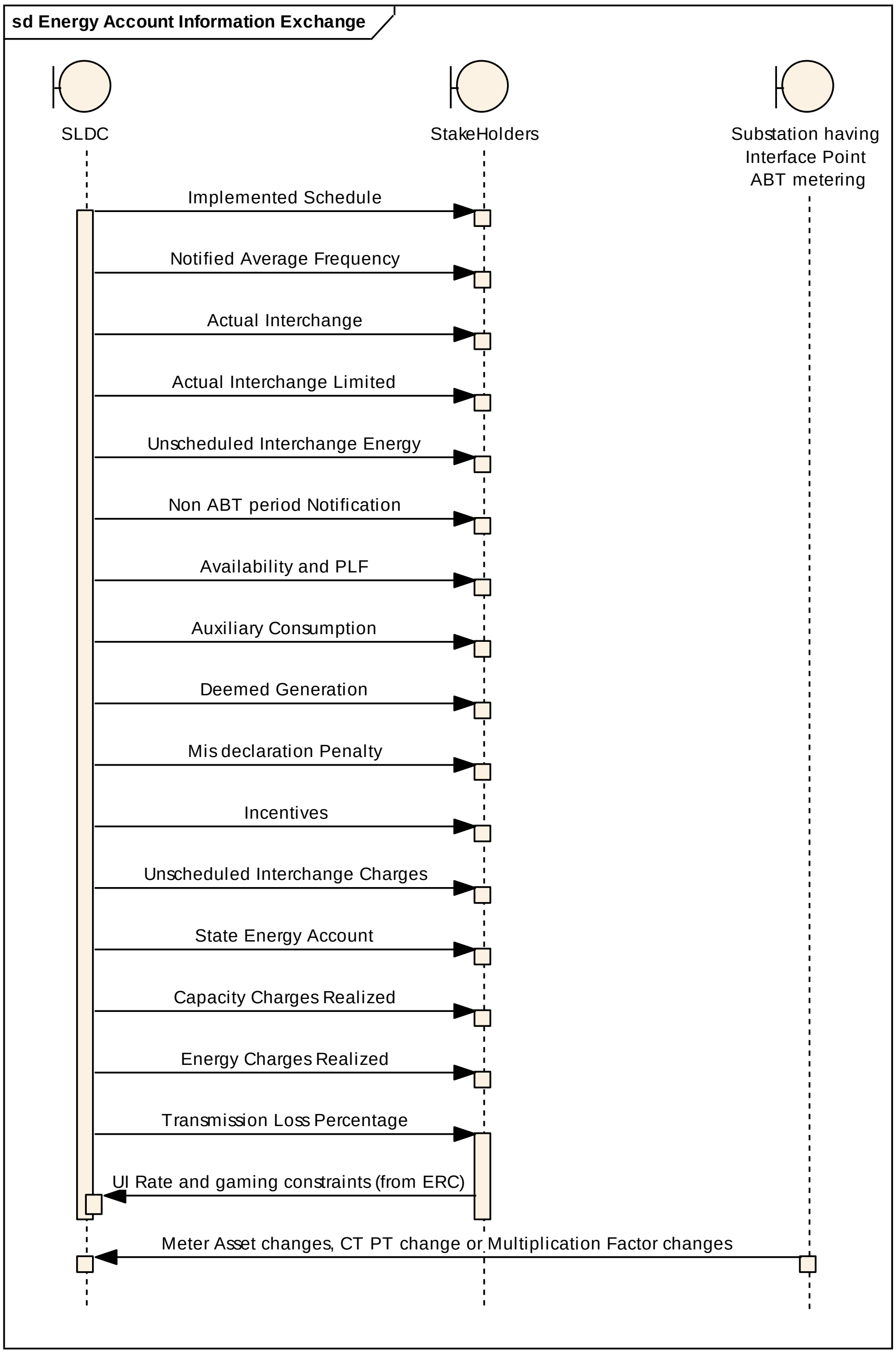

Figure 4 Energy Accounting and Charges information exchange

ABT meter data collection is the primary activity for preparing an energy account.

4.2. ABT METER DATA

To prepare Energy account under ABT mechanism, the basic requirement is 15 minute block wise (ABT) Load survey data.

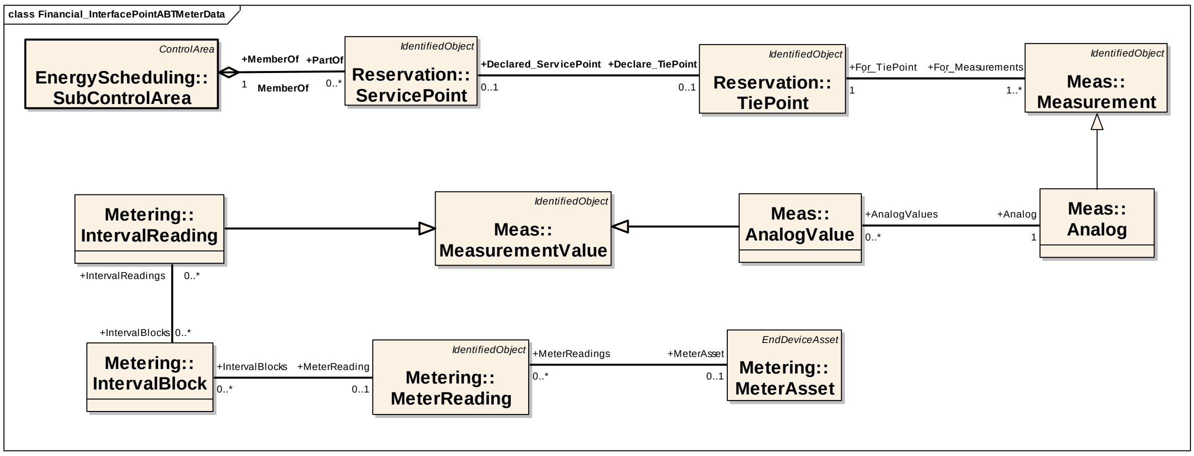

Figure 5 ABT Meter Data

ABT meter data is acquired both offline and online mode. The present classes in CIM under packages ***MEAS*** and ***METERING*** are used for modeling ABT meter data. In ABT meter data acquisition, the multiplication factor is applied at Control center rather than at substation. Hence the Meter asset changes, CT/PT changes, multiplication factor changes are communicated from substations to SLDC control centre. The quality of the data is validated and the CIM class used for the purpose is ***Metering:Quality***. The ***SubControlArea*** is bounded by metering points at ***Tiepoint***. The 15 minute block wise ABT meter reading is represented using ***Metering::IntervalReading – IntervalBlock – MeterReading – MeterAsset.*** The measurement using ABT meter at ServicePoint - TiePoint of Utility is represented using ***SubControlArea – ServicePoint – TiePoint – Measurement.***

4.3. ABT ENERGY ACCOUNT AND CHARGES

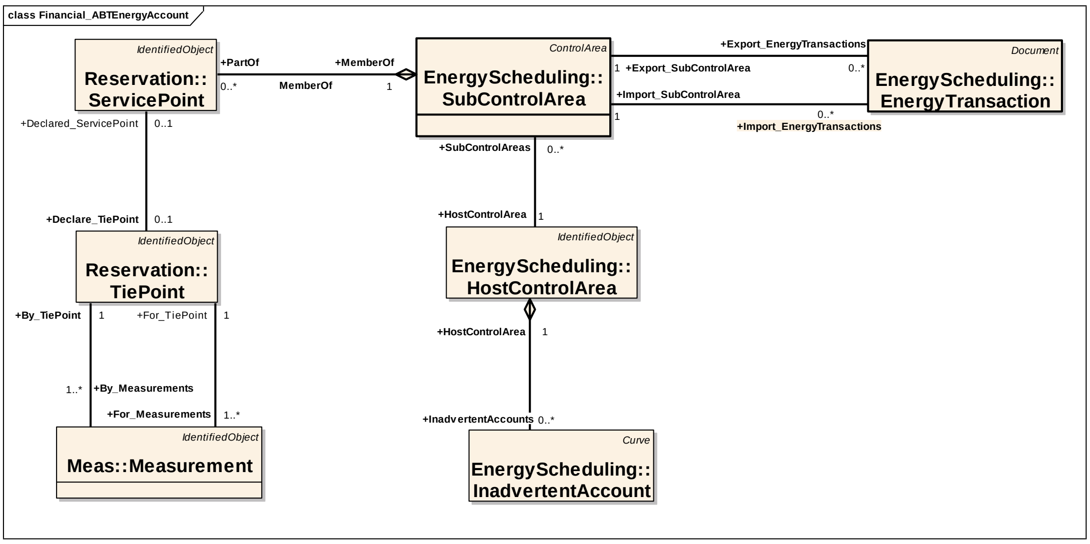

Figure 6 ABT Energy Account

The State Energy account is prepared based on Capability Declaration, Schedule Interchange, Actual Interchange, and Entitlement. Applying Tariff on the energy account will result in Charges. ABT mechanism has four part charge mechanism. They are Capacity charges and its realization, Energy Charges, Unscheduled Interchange Charges and Reactive Energy Charges. Modeling ABT Charges and Balancing & Settlement in CIM is not possible with the available CIM classes due to the unique requirements of Availability Based Tariff Mechanism. Of the multiple charges under ABT mechanism, Unscheduled Interchange charges is the most important charge. It can be modeled using ***EnergyScheduling::InadvertentAccount.*** Other charges cannot be modeled with existing CIM classes. Hence CIM requires extension. The extension classes for ABT structure and charges should be able to model the following concepts of ABT: Capacity Charge, Energy Charge Tariff, UI Rate, Reactive Energy Rate, Notified Availability Target, Notified PLF Target, Notified Incentive Rate, Notified Transmission Tariff, Notified Auxiliary Consumption Limit, Actual Availability, Capacity Charge Realized, Energy Charge, Actual PLF, Reactive Energy Charge, Unscheduled Interchange Charge, Transmission Charge, and Incentive. Extensions for ABT structure and charges will be carried out in future work.

5. DESCRIPTION OF CIM CLASSES INVOLVED

The CIM classes involved in modeling ABT are described. The original definitions provided by CIM is presented.

Analog
Analog represents an analog Measurement.

AnalogValue
AnalogValue represents an analog MeasurementValue.

EnergyTransaction
Specifies the schedule for energy transfers between interchange areas that are necessary to satisfy the associated interchange transaction.

HostControlArea
A HostControlArea has a set of tie points and a set of generator controls (i.e., AGC). It also has a total load, including transmission and distribution losses.

InadvertantAccount
An account for tracking inadvertent interchange versus time for each control area. A control area may have more than one inadvertent account in order to track inadvertent over one or more specific tie points in addition to the usual overall net inadvertent. Separate accounts would also be used to track designated time periods, such as on-peak and off-peak.

IntervalBlock
Time sequence of Readings of the same ReadingType.

IntervalReading
Data captured at regular intervals of time. Interval data could be captured as incremental data, absolute data, or relative data. The source for the data is usually a tariff quantity or an engineering quantity. Data is typically captured in time-tagged, uniform, fixed-length intervals of 5 min, 10 min, 15 min, 30 min, or 60 min.
Note: Interval Data is sometimes also called "Interval Data Readings" (IDR).

LossProfile

LossProfile is associated with an EnerrgyTransaction and must be completely contained within the time frame of the EnergyProfile associated with this EnergyTransaction.

Measurement
A Measurement represents any measured, calculated or non-measured non-calculated quantity. Any piece of equipment may contain Measurements, e.g. a substation may have temperature measurements and door open indications, a transformer may have oil temperature and tank pressure measurements, a bay may contain a number of power flow measurements and a Breaker may contain a switch status measurement.

MeasurementValue
The current state for a measurement. A state value is an instance of a measurement from a specific source. Measurements can be associated with many state values, each representing a different source for the measurement.

MeterAsset
Physical asset that performs the metering role of the ServiceDeliveryPoint. Used for measuring consumption and detection of events.

MeterReading
Set of values obtained from the meter.

ServicePoint
Each ServicePoint is contained within (or on the boundary of) an ElectronicIinterchangeArea. ServicePoints are defined termination points of a transmission path (down to distribution level or to a customer - generation or consumption or both).

SubControlArea
An area defined for the purpose of tracking interchange with surrounding areas via tie points; may or may not serve as a control area.

TieLine
The SubControlArea is on the A side or B side of a collection of metered points which define the SubControlArea's boundary for a ControlAreaOperator or CustomerConsumer.

TiePoint
Site of an interface between interchange areas. The tie point can be a network branch (e.g., transmission line or transformer) or a switching device. For transmission lines, the interchange area boundary is usually at a designated point such as the middle of the line. Line end metering is then corrected for line losses.

6. CONCLUSION

The ABT based energy scheduling and accounting process involves information exchange between generating stations, beneficiaries, load dispatch centres and power committees. The exchange format needs to be uniform so that it can be seemlessly integrated to varied software systems installed in these utilities, without need for code level changes. The information exchange requirenents are identified. Modeling of ABT Energy Scheduling and Energy Accounting mechanism in CIM is prepared. CIM models of energy scheduling by load dispatch centre, and energy accounting and billing by power committee are presented. It is found out that ABT energy scheduling and ABT special energy meter data can be modeled without extensions, and energy accounting can be modeled by extending CIM. The extension requirements will be carried out in future work.

BIBLIOGRAPHY

Laakshmana Sabari C has 10 years of experience in design, development and implementation of software applications for power sector. He is instrumental in the design and management of products and solutions of Kalkitech for power sector optimization applications. He has implemented Energy Scheduling (availability based tariff - ABT), Accounting and Analysis solution at various load despatch centres and generation utilities. His research areas include CIM extensions for Indian scenario, CIM for energy systems and distribution sector, and smart grid. He is member of Working Group (WG3) on (CIM) of BIS LITD 10 Power System Control and Associated Communications Sectional Committee. He holds Master degree in Energy Conservation and Management from School of Energy, Bharathidasan University, Tiruchirapalli. He is currently pursuing PhD in energy systems at IIT Bombay.

Jose Thomas is Vice President, Optimization Technology vertical of Kalkitech and a Bachelor of Technology holder in Control Systems from University of Calicut and has more than 9 years of experience in Electric Utility industry with area of specialization in various operational system engineering, power system communication Protocols, application of wired and wireless communication technologies, and SCADA-IT application integration. Jose Thomas was instrumental in conceptualizing Generic Protocol Conversion engine used in Kalkitech protocol gateways and is now responsible for the product management activities of Kalkitechs optimization products. He is an executive committee member of IEEE PES Bangalore chapter and also a member of BIS LITD-10 Committee (TC57 Indian National Committee) Member, and the secretary of Working Group on CIM (IEC-61970, 61968 and 62325).