Inter-SC Trades for California ISO Nodal Market Tutorial

Version 1.3

Revision History

Date	Version	Description	Author
Jan 25, 2005	1.0	Initial Version	Tong Wu
January 10, 2006	1.1	Additions and cleanup for publication.	Benik Der-Gevorgian
January 20, 2006	1.2	Additions and cleanup for publication.	Margaret Miller
November 7, 2006	1.3	Updated document with current terminology	Margaret Miller

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Inter-SC Trades

1. Introduction

Recently FERC approved in principle the California Independent System Operator Corporation's (CAISO's) conceptual proposal to establish settlement services for bilateral energy transactions at generation nodes within the CAISO control area and at aggregated pricing points. This order benefits customers by offering a settlement service for bilateral contracts.

In today's market design SCs must submit a balanced schedule to the CAISO. Inter-SC trades are used to help balance Scheduling Coordinators portfolio of forward energy schedules. The CAISO cannot run today's forward market until all SCs schedules are balanced.

Under the California ISO Nodal Market, the CAISO will be eliminating the balanced schedule requirement and in so doing will be creating a forward energy market (i.e., SCs will be able to come into the forward market with unbalanced portfolios and bid to purchase and sell energy). With the introduction of a forward energy market, Inter-SC Trades are no longer needed to balance schedules and in fact are no longer an essential or required element of the market design. Their only role under a forward energy market is to provide a settlement service for bilateral energy contracts. The settlement service offered by Inter-SC Trades is optional in the sense that the counter-parties to a bilateral contract could elect to settle their bilateral contract outside of the CAISO settlement system.

There will be three types of Inter-SC Trades:

Inter-SC Trades of Energy
An Inter-SC Trade (IST) is an energy quantity (MWh) traded from one SC to another SC for a specific hour, trade place, and market. An IST of energy can be conducted at a Trading Hub, Load Aggregation Point or at a Generating Resource's location. An APN (Aggregate Pricing Node Trade) will be conducted at a Trading Hub or a Load Aggregation Point, both of which are aggregations of network nodes. A PHY (Physical Trade) will be conducted at a specific Generator Resource's location and the quantity of the PHY is dependent on the forward market energy schedule of the Generator Resource[1]. The From-SC of the PHY being submitted must specify another PHY that the PHY being submitted must depend on if the From-SC is not the SC that schedules the Generator Resource where the PHY being submitted is rooted.

Inter-SC Trades of Ancillary Services
An Ancillary Services Trade (AST) is an AS quantity (MW) traded from one SC to another SC for a specific hour and AS type. There are four types of ASTs as illustrated in Figure 10, namely:
- Regulation Up Trades
- Regulation Down Trades
- Spinning Reserve Trades
- Non-Spinning Reserve Trades

Inter-SC Trades of IFM Unit Commitment Cost Obligation
A Unit Commitment Cost Obligation Trade (UCT) also known as IFM Load Uplift Obligation, is a quantity (MWh) traded from exactly one SC to another SC for a specific hour. The IFM Unit Commitment Cost (UCC) Obligation, measured in MWh, is the billing determinant for allocating the total UCC for an hour. The mechanism of Inter-SC Trade of UCC Obligation allows an SC to transfer an agreed upon amount of UCC obligation to another SC that is willing to accept this payment obligation for a premium that is negotiated outside of any CAISO market and settlement systems.

Web link:

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[1] The qualification process is further described by business rules in subsequent sections.

2. Inter-SC Trades of Energy

2.1 IST Content

An SC can submit zero or a positive number of Inter-SC Trades from the SC. An SC can submit zero or a positive number of Inter-SC Trades to the SC. An SC can have many ISTs of any type with another same SC at the same location (which is either a Trading Hub or Load Aggregation Point for APNs or a Generator Resource for PHYs) or at different locations. In order to distinguish the multiple ISTs of the same type at the same location for the same hour in the same Forward Market between the same pair of SCs, a unique IST Name must be selected for each of the ISTs. Specifically, we will require that the To-SC must choose a unique IST Name for each of the ISTs in its portfolio that share the following attributes:

> ➢ To-SC Identifier

> ➢ Market Type (DA or HA/RT)

> ➢ Trade Time Period

> ➢ IST Type (APN, PHY)

> ➢ Trade Place (Trade Hub or Load Aggregation Point for APN, or Generation for PHY)

The complete list of attributes for an IST on submission is given as follows:

IST	
PK	**Submission_SC_ID**
PK	**Submission_Time**
PK	**IST_Name**
PK	**To_SC_ID**
PK	**IST_Type (FIT, PIT, CFT)**
PK	**Trade_Place (Hub, Gen_ID)**
PK	**Trade_Time_Period**
PK	**Market_Type (DA, HA/RT)**
	Quantity (MW) **From_SC_ID** Depend_On_IST_Name

2.2 Settlements

An Inter-SC Trade (IST) involves two SCs: the "from" SC and the "to" SC. By definition in this document, the "from" SC is charged the same amount that the "to" SC is paid. Specifically, the "from" SC will be charged the product of the valid quantity of the "from" Inter-SC Trade and the LMP at the appropriate Price Location. The "to" SC will be paid the product of the valid quantity of the "to" Inter-SC Trade and the LMP at the appropriate Price Location.

Example:

Physical Inter-SC Trades are used to facilitate the settlement of the Seller's Choice Contracts. This example illustrates how to use Inter-SC Trades to facilitate the settlement of the Seller's Choice Contracts. Suppose that SC1 sells 100MW to SC2 at $15/MW under a bilateral contract, which is settled outside of the ISO market. Furthermore, assume that under the bilateral contract, the seller SC_1 will deliver the energy at generator G's location. To execute the Seller's Choice Contract through the ISO, an IST from SC_1 to SC_2 should be arranged between SC_1 and SC_2 as shown in Figure 1. Assuming the IST passes all the validation rules associated with the IST design, the settled results are shown in Table 1.
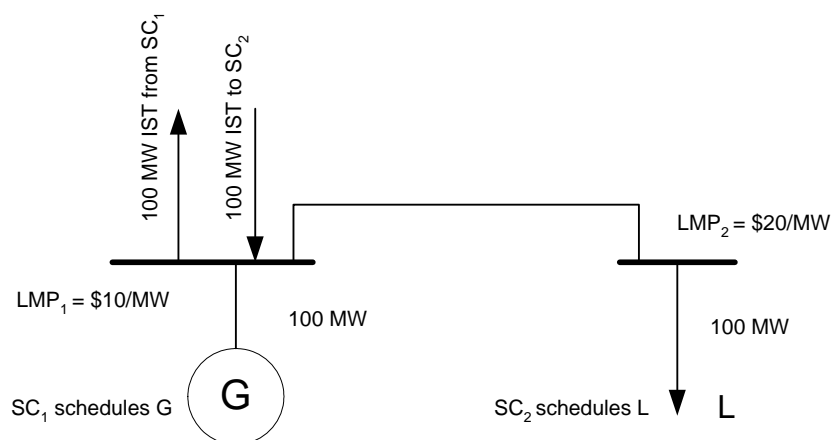
Figure 1 Illustration of Orientation of Inter-SC Trades

As is shown in Table 1, SC1 is paid $1000 for providing the 100 MWh of energy to the market regardless of the IST. SC1 is charge $1000 for being the From-SC of the IST. SC2 is charged $2000 for consuming 100 MWh at the load location regardless of the IST. SC2 is paid $1000 for being the To-SC of the IST. The net results to SC1 and SC2 is that SC2 pays the congestion charge of $1000 implicitly.

Table 1 Illustration of Inter-SC Trade Orientation and Settlement

		SC1	SC2
Bilateral Contract		$1500	-$1500
ISO settlement	Generation Payment	$10/MWh *100MWh=$1000	
	From-IST Charge	$10/MWh *(-100MWh)=-$1000	
	Load Charge		$20/MWh *(-100MWh)=-$2000
	To-IST Payment		$10/MWh *100MWh=$1000
	ISO total	$0	-$1000
Net Result		$1500	-$2500

3.   Validation of Inter-SC Trades of Energy

APNs will be validated for content and for a matching counter-party trade prior to market close. Any APNs that do not have a matching counter-party trade at the close of the market will be rejected and the SC will be notified.

PHYs will be validated prior to and after the forward energy market clears. Scheduling Coordinators must demonstrate (either directly or through an Inter-SC Trade with another supplier) that their trade is supported by a transmission feasible generator resource scheduled at the same generation node that has capacity that is equal to, or greater than, the amount of the trade.

The validation process for PHYs includes a pre-market and post-market validating process. According to the CAISO, prior to market clearing, individual trades that exceed a resource's capacity will not be validated by the CAISO and will be sent back to the Scheduling Coordinator. Additionally, if a series of linked trades drawing on a single resource are individually valid but collectively exceed the resource's schedule or offered quantity, each of the Inter-SC Trades relying on the oversubscribed resource will be reduced on a pro-rata basis until the Inter-SC Trades are valid.

The volume of PHYs that pass the pre-market validation process may be reduced after the forward market clears if the generation unit supporting the Inter-SC Trade has a final market schedule that is below the quantity of Inter-SC Trades at that location. The megawatt quantities of the Inter-SC Trades that are adjusted down during this post-market validation process will be converted to trades at the EZ Gen Hub price of the existing congestion zone containing the generator. The portion of the Inter-SC Trade that remains will be settled at the LMP for the selected generation node.

Inter SC Trades of Energy will be submitted to either the Day-Ahead or the Real-Time (HASP) market. The market timeline for trades is slightly different from the market timeline for bid submission.

Day-Ahead Market
Trades for the Day-Ahead Market may be submitted beginning 7 days prior to the trading day until the market close time for trades of 12:00 p.m the previous day. Only Inter-SC trades of energy will be submitted in the day-ahead market because they may be settled at different DA and RT prices. During the time the market is open the CAISO will validate the ISTs for content as well as search for the matching IST submitted by the designated trading counter-party.

At 12:00 p.m. the CAISO will reject any ISTs that do not have a matching counter-party IST. Since PHYs are also dependent upon a designated generating resource's bid the CAISO will adjust the quantity of PHYS if necessary based on the bid received by the generating resource that the PHY is dependent on.

At 1:00 p.m. the CAISO will conduct a Post-Market Validation on PHYs based on final Day-Ahead market results from IFM. Any invalid portions of Physical trades where the dependent generating resource's final schedule does not cover the PHY amount will become Converted Physical Trades (CPT). The result of the CPT will be saved and made available to the relevant SCs.

Real-Time Market (HASP)
Trades for the RT market may be submitted up to 24 hours prior to the trading hour until the market close time for trades of T-45. During the time the market is open the CAISO will validate the ISTs for content as well as search for the matching IST submitted by the designated trading counter-party. At T-45 the CAISO will reject ISTs that do not have a matching counterparty IST. PHYs will be adjusted if necessary based on the bid received by the generating resource that the PHY is dependent on.

At T-30 the CAISO will conduct a Post-Market Validation on PHYs based on final HASP results. Any

invalid quantities where the dependent generating resource's final schedule does not cover the PHY amount will become a Converted Physical Trade (CPT). The result of the CPT will be saved and made available to the relevant SCs.

3.1 Timeline of Business Events and Validation Stages

Table 2 Timeline of Business Events and Validation Stages

Stages	DA Timeline	RT Timeline	Events
1	Up to T-7 days prior to the trading day	Up to 24 hours prior to the trading hour.	Scheduling Coordinators (SCs) continuously submit Inter-SC Trades (ISTs) together with the Bids to the ISO. The ISO continuously screens each submitted IST to check the contents of the IST and search for its matching IST submitted by the counter-party SC. The ISO provides feedback to the SCs about the validity of the ISTs based on the information that is available to the ISO at the time.
2	Between T-7 days and – 12:00 noon the day prior to the trading day . The Trade Close Time shall be a configurable time between Market Close Time and market results publication time, i.e., 1:00 pm for DAM.)	Between T-135 and T-45 min (Assuming T-45 min is the Trade Close Time for IST submissions in HA. The Trade Close Time shall be a configurable time between HASP Market Close Time and market results publication time, i.e., T-30 min for HASP.)	Scheduling Coordinators (SCs) continuously submit Inter-SC Trades (ISTs) before Trade Close Time and Bids before Market Close Time to the ISO. The ISO continuously screens each submitted IST to check the contents of the IST and search for its matching IST submitted by the counter-party SC. The ISO at this stage performs the Pre-Market Validation to evaluate and adjust PHYs, if necessary, based on Generator Resource Energy Bids (to the extent that they are available) at pre-specified time intervals (e.g., every 20 minutes and at the Trade Close Time) The ISO provides feedback to the SCs about the validity of the ISTs based on the information that is available to the ISO at the time.
3	At 1:00 pm	At T-30 min	The ISO performs Post-Market Validation of the ISTs based on the IFM (or HASP) results and convert invalid portions of Physical Trades (PHYs) to Converted Physical Trades (CPTs). The ISO stores the final ISTs and send them back to the SCs.

3.2 Validation Relationship Diagram

An entity-relationship diagram is given in Figure 2 that describes the data involved in the Inter-SC Trade (IST) processing.
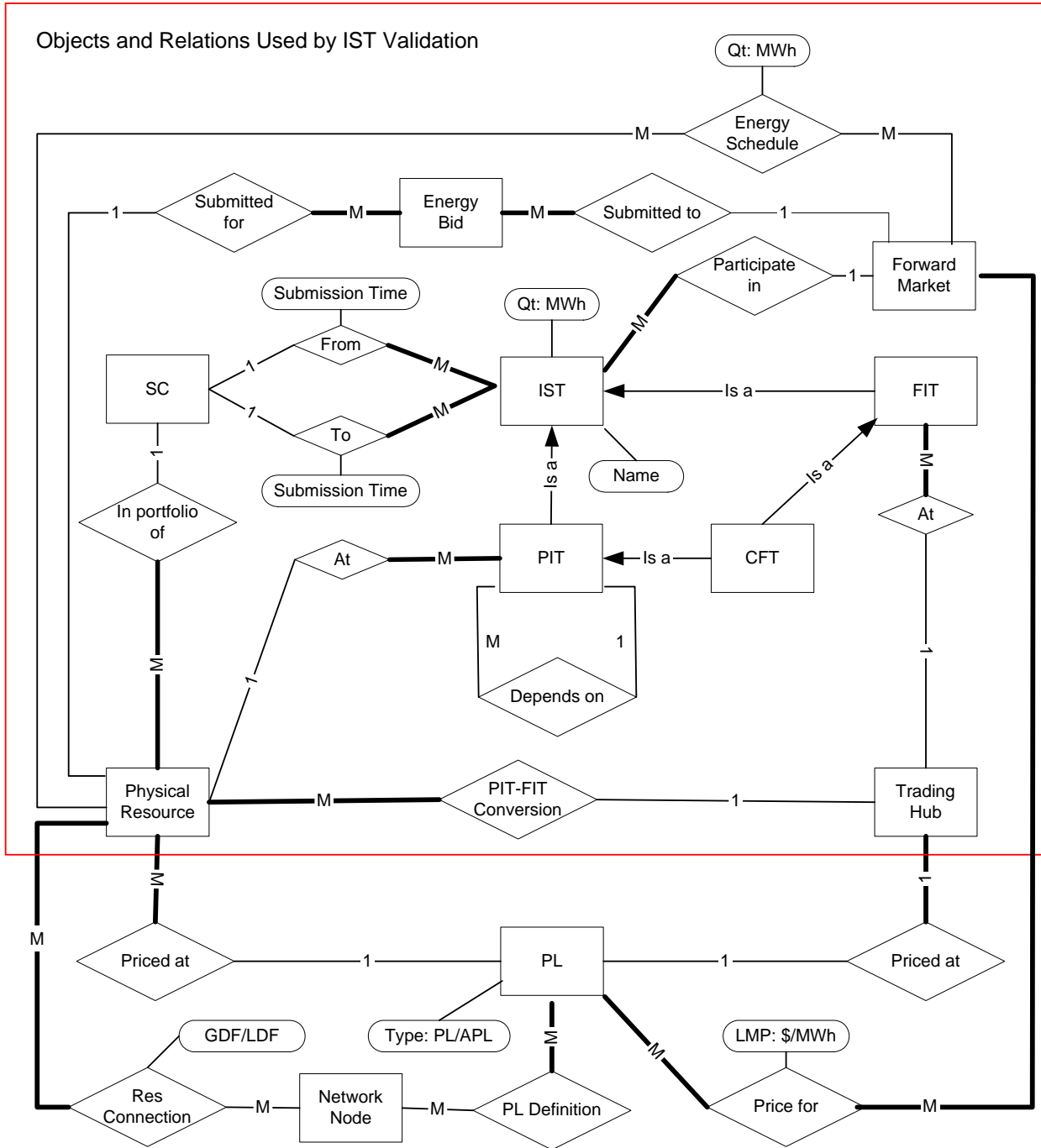
Figure 2   Object Relational Description of the Data involved in IST Processing

3.3 Validation States of Inter-SC Trades of Energy

An Inter-SC Trade experiences in various validation stages the following states as shown in Figure 3.
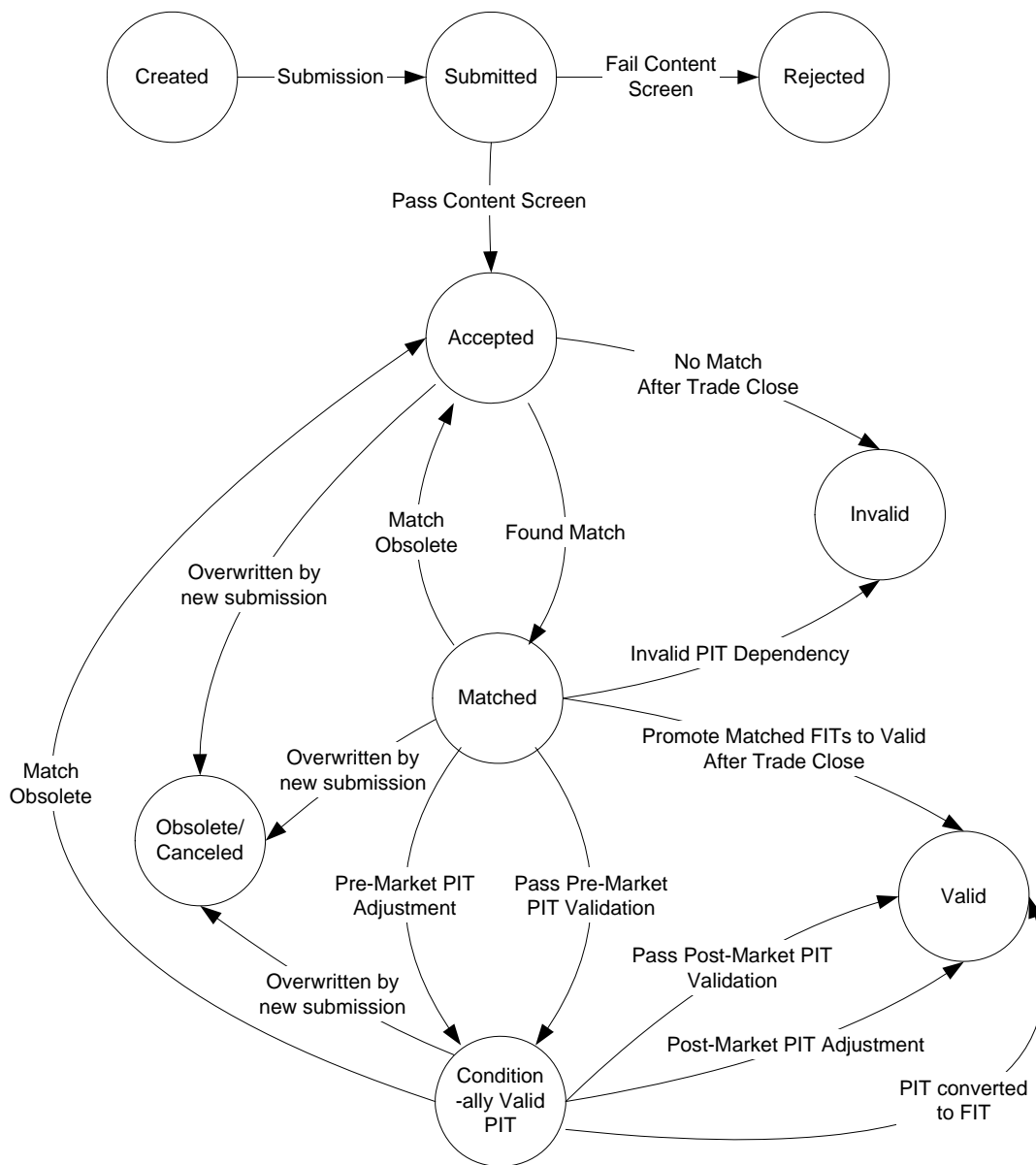

Figure 3 State Transition Diagram of IST

An Inter-SC Trade experiences in Stage 1 validation (as described in Table 1) the following states as shown in Figure 4.
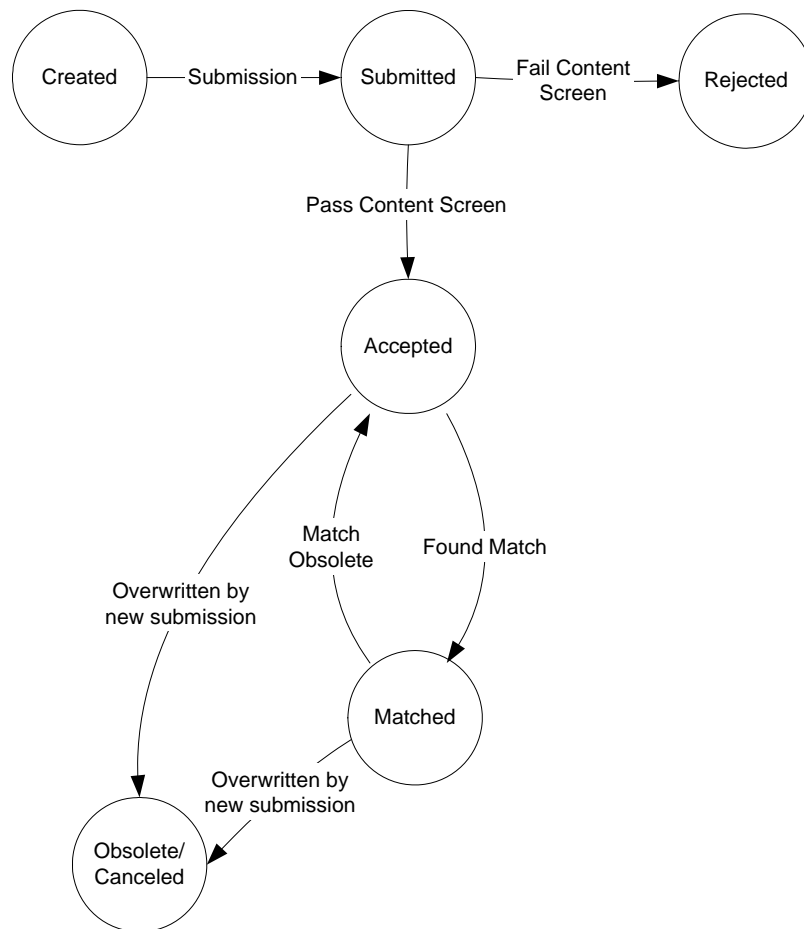

Figure 4 State Transition Diagram of IST in Stage 1 Validation

An Inter-SC Trade experiences in Stage 2 validation (as described in Table 1) the following states as shown in Figure 5.
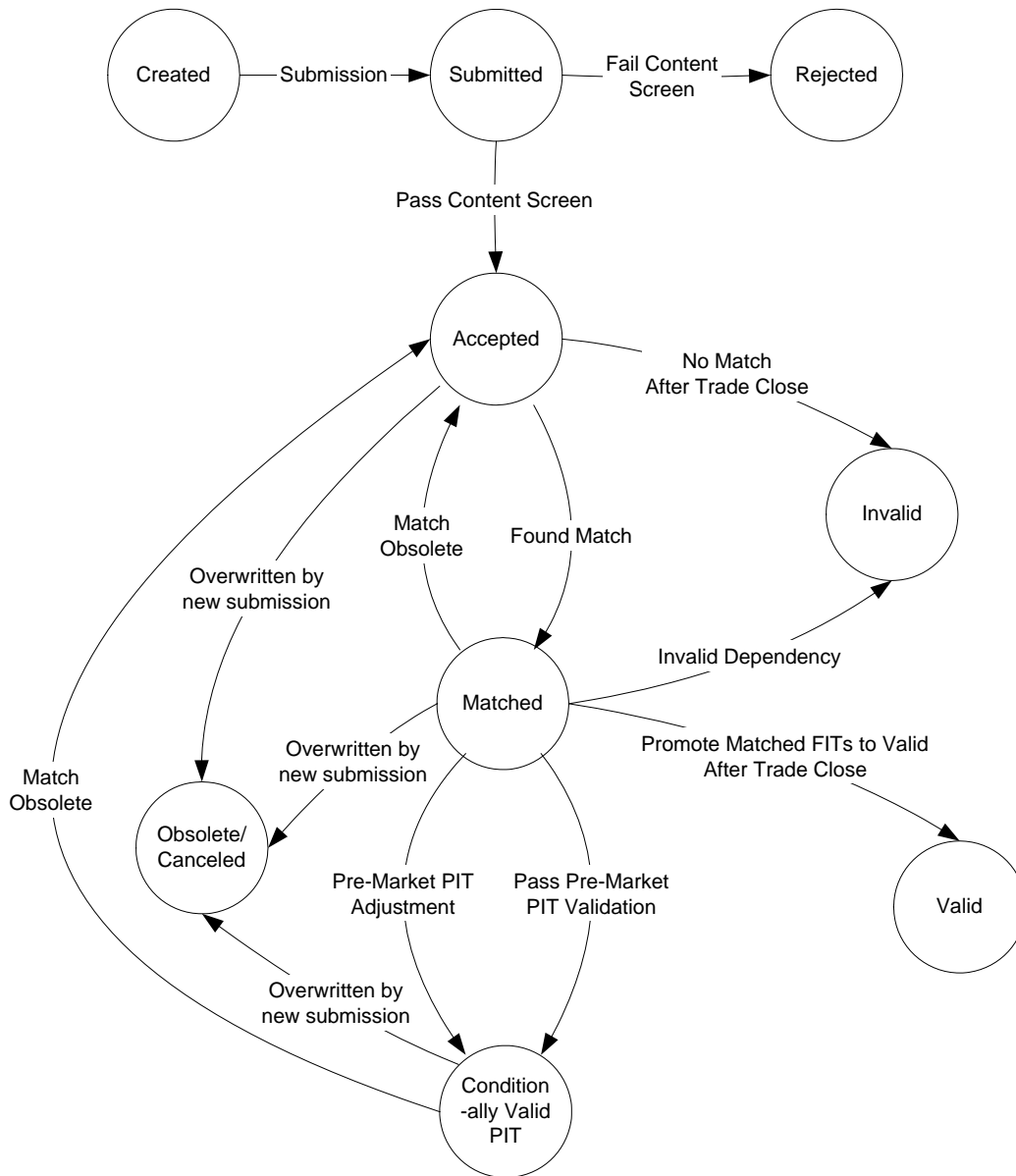

Figure 5 State Transition Diagram of IST in Stage 2 Validation

An Inter-SC Trade experiences in Stage 3 validation (i.e., after publication of the forward market results, as described in Table 1) the following states as shown in Figure 6.
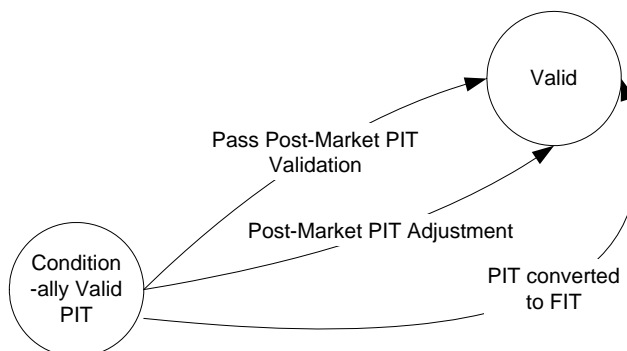

Figure 6 State Transition Diagram of IST in Stage 3 Validation

3.4 Dependency of Physical Inter-SC Trades

Each Generator Resource can support a set of PHYs, which are represented by a network diagram and a tree diagram. An example is given in Figure 57. The network diagram in Figure 57 represents the trading relationships among the SCs, in which each node represents a SC, and each arc represents a PHY. The tree diagram in Figure 57 represents the dependency of the PHYs, in which each node represents a PHY, and each child PHY depends on a single parent PHY.

A PHY from an SC X to another SC Y can specify the Generator Resource that supports the PHY (as the depend-on IST) if SC X schedules the Generator Resource. Otherwise, a PHY from SC X to SC Y must specify another PHY as the depend-on IST of which the To-SC is SC X. Moreover, the dependency must not form a circular relationship as is illustrated in Figure 58. The PHYs that are involved in any circular dependency relationship are deemed as invalid.
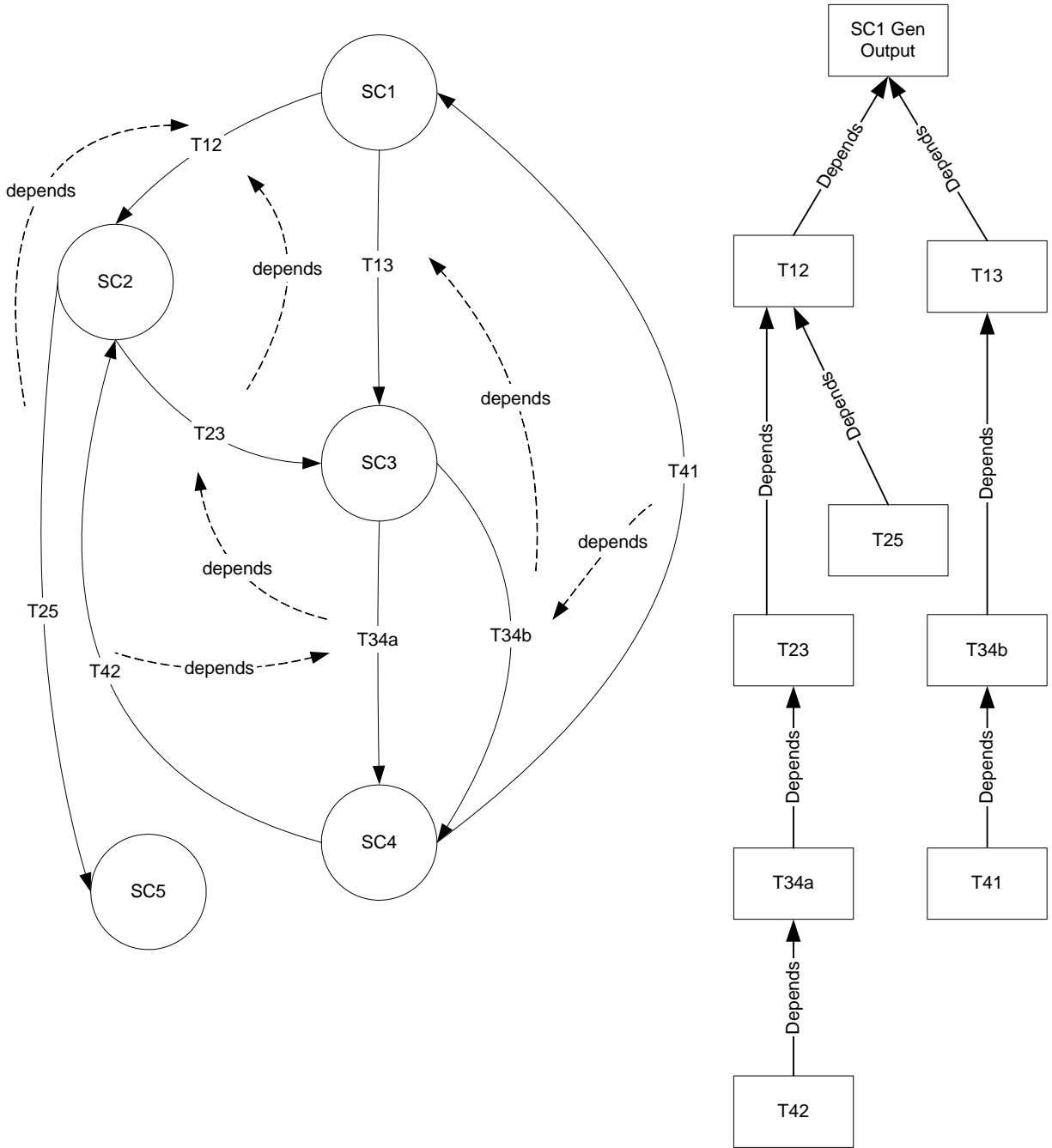
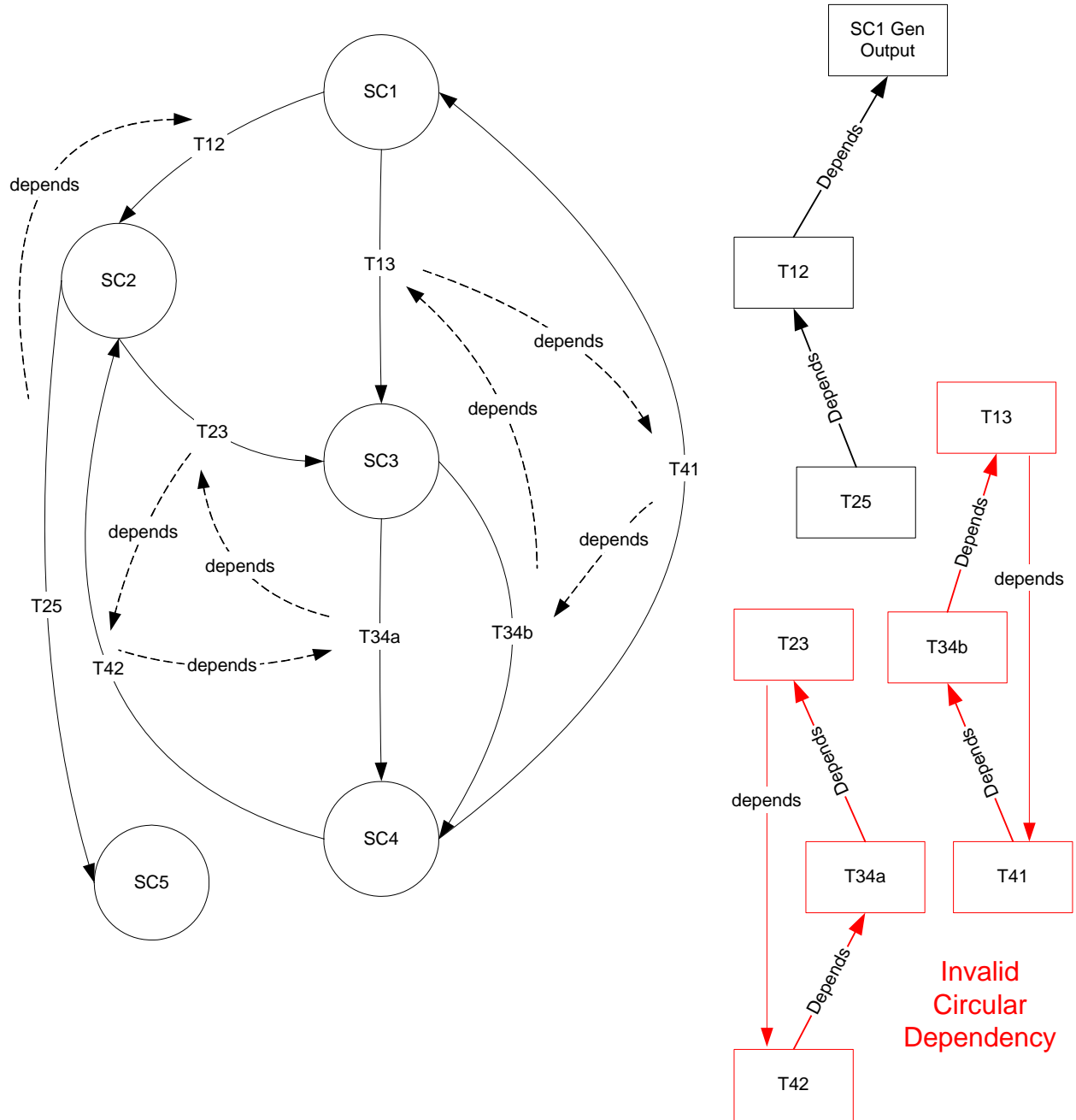**Figure 7 Dependency of Physical Inter-SC Trades**

Figure 8 Circular Dependency of Physical Inter-SC Trades

4.   IST of Ancillary Services

4.1 Content of ASTs

An SC can submit zero or a positive number of ASTs <u>from</u> the SC. An SC can submit zero or a positive number of ASTs <u>to</u> the SC. An SC can have at most one AST of each type with another same SC for the same Trade Period. The complete list of attributes for an IST on submission is given as follows:

AST	
PK	**Submisison_SC_ID**
PK	**From_SC_ID**
PK	**To_SC_ID**
PK	**AST_Type (SPT, NST, RUT, RDT)**
PK	**Trade_Time_Period**
PK	**Submission_Time**
	Quantity (MW)

Figure 9 Attributes of an AST

4.2 Settlements

Inter-SC Trades of Ancillary Service (AST), measured in MW, are settled by the system-wide user rate of a type of service for a specific hour, independent of the markets. The user rate is used to allocate the total cost of procuring a type of ancillary service for an hour regardless in which market the cost is incurred. For example, if the combined DA and RT cost of procuring spinning reserve for an hour is $X, and the total spinning reserve net procurement (excluding self-provision) for the entire market is Y MW, then the user rate for spinning reserve for the hour is (X/Y) in $/MWh. If SC 1 trades Z MW of spinning reserve to SC 2, SC 1 will be paid and SC 2 will be charged $ (X/Y)*Z, respectively.[2] The CAISO will allow both SCs to inform the CAISO about the Z MW of Trade of Ancillary Service from SC 1 to SC 2 and settle the trade for them.

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[2] The CAISO will not use a specific charge type for ASTs, i.e., there would not be explicit payments or charges for AST; their effect would rather be taken into account in the relevant AS Cost Allocation; ASTs would modify the AS Capacity Obligation for the relevant SCs.

4.3 Validation of IST of AS

ASTs are validated for content and for a matching counter-party AST trade. ASTs are submitted following the Real-Time (HASP) market timeline for trades. Since ASTs are settled based on the system wide user rate they are not dependent on the outcome of the Real-Time market. However, for simplicities sake they will be submitted on the same Real-Time (HASP) timeline as the Inter-SC Trades of Energy.

Table 3 Timeline of Business Events for ASTs

Timeline	Events
Before T-45 min (Assuming T-45 min is the Trade Close Time for AST submissions. The Trade Close Time shall be a configurable time. Here T-45 is chosen to be consistent with the HA Trade Close Time for IST of energy.)	Scheduling Coordinators (SCs) continuously submit ASTs before the Trade Close Time for ASTs. The ISO continuously screens each submitted AST to check the contents of the AST and search for its matching AST submitted by the counter-party SC. The ISO provides feedback to the SCs about the validity of the ASTs based on the information that is available to the ISO at the time.

4.4 Validation Relationship Diagram for Inter-SC Trade of Ancillary Services

An AST is an AS quantity (MW) traded from exactly one SC to another SC for a specific hour and AS type. There are four types of ASTs as illustrated in Figure 10, namely:
  − Spinning Reserve Trades (SPT),
  − Non-Spinning Reserve Trades (NST),
  − Regulation-Up Trades (RUT), and
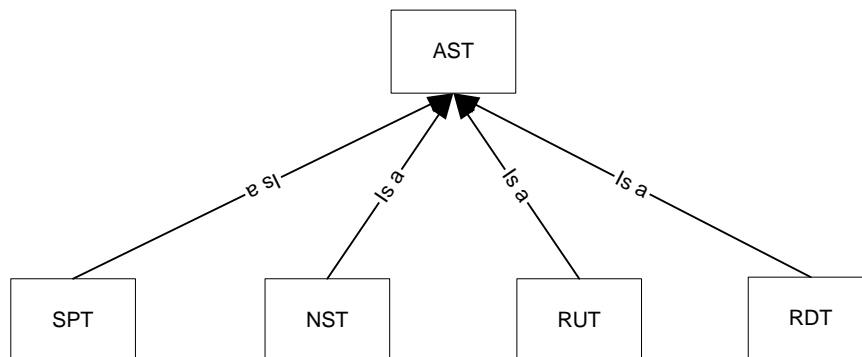 − Regulation-Down Trades (RDT).

Figure 10   Type of Inter-SC Trade of Ancillary Service

4.5 Validation States of Inter-SC Trades of Ancillary Service

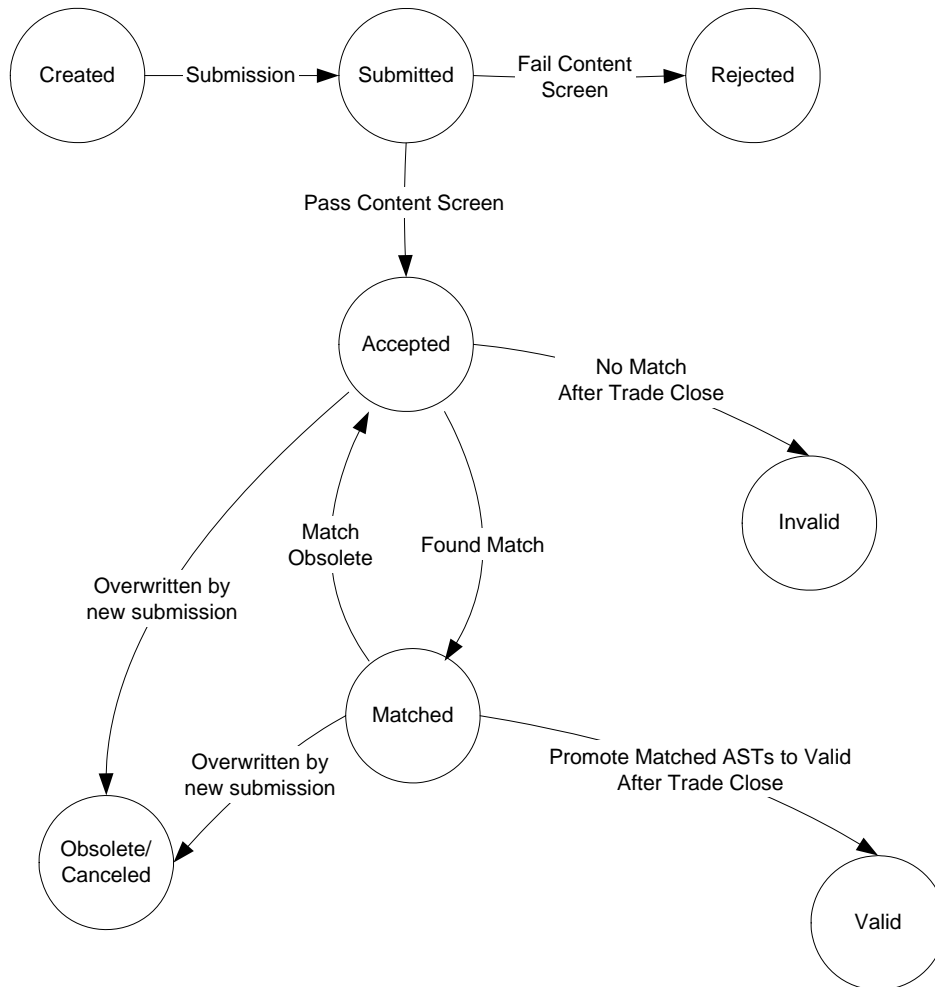An AST experiences in the validation process the following states as shown in Figure 11.

Figure 11 State Transition Diagram of AST

5.   IST of IFM Unit Commitment Cost (UCC) Obligation

5.1 Content of UCTs

An UCT is a quantity (MWh) traded from exactly one SC to another SC for a specific hour. An SC can submit zero or a positive number of UCTs <u>from</u> the SC. An SC can submit zero or a positive number of UCTs <u>to</u> the SC. An SC can have at most one UCT with another same SC for the same Trade Period. The complete list of attributes for an UCT on submission is given as follows:

UCT	
PK	<u>Submisison_SC_ID</u>
PK	<u>From_SC_ID</u>
PK	<u>To_SC_ID</u>
PK	<u>Trade_Time_Period</u>
PK	<u>Submission_Time</u>
	Quantity (MW)

Figure 12 Attributes of an UCT

5.2 Settlements of UCTs

IFM Unit Commitment Cost (UCC) Obligation, measured in MWh, is the billing determinant for allocating the total UCC for an hour. For example, if the UCC for an hour is \$X, and the total UCC obligation for the entire market is Y MWh, then the User Rate for allocation of the UCC for the hour is (X/Y) in \$/MWh. If the UCC obligation for SC 1 is Z MWh, then SC 1 is obligated to pay \$ (X/Y)*Z. The mechanism of Inter-SC Trade of UCC Obligation allows SC 1 to transfer any reasonable amount (say Q MWh) of UCC obligation to another SC 2 that is willing to accept this payment obligation for a premium that is negotiated outside of any CAISO market and settlement systems. The CAISO will allow both SCs to inform the CAISO about the Q MWh of Trade of UCC Obligation from SC 1 to SC 2 and charge the UCC associated with the Q MWh of UCC obligation in the amount of \$ (X/Y)*Q to SC 2 instead of SC 1. Moreover, SC 1 is charged \$(X/Y)*(Z-Q) instead of \$(X/Y)*Z; moreover, if Q > Z, SC 1 will effectively receive a payment.

5.3 Timeline of Business Events and Validation of IST of UCC Obligations

UCTs are validated for content and for a matching counter-party UCT trade. Similar to ASTs, UCTs are submitted following the Real-Time (HASP) market timeline for trades to be consistent with the time line for submission for Real-Time market ISTs of Energy.

Table 4 Timeline of Business Events for UCTs

Timeline	Events
Before T-45 min (Assuming T-45 min is the Trade Close Time for UCT submissions. The Trade Close Time shall be a configurable time. Here T-45 is chosen to be consistent with the HA Trade Close Time for IST of energy.)	Scheduling Coordinators (SCs) continuously submit UCTs before the Trade Close Time for UCTs. The ISO continuously screens each submitted UCT to check the contents of the UCT and search for its matching UCT submitted by the counter-party SC. The ISO provides feedback to the SCs about the validity of the UCTs based on the information that is available to the ISO at the time.

5.4 Validation States of Inter-SC Trades of UCC Obligations

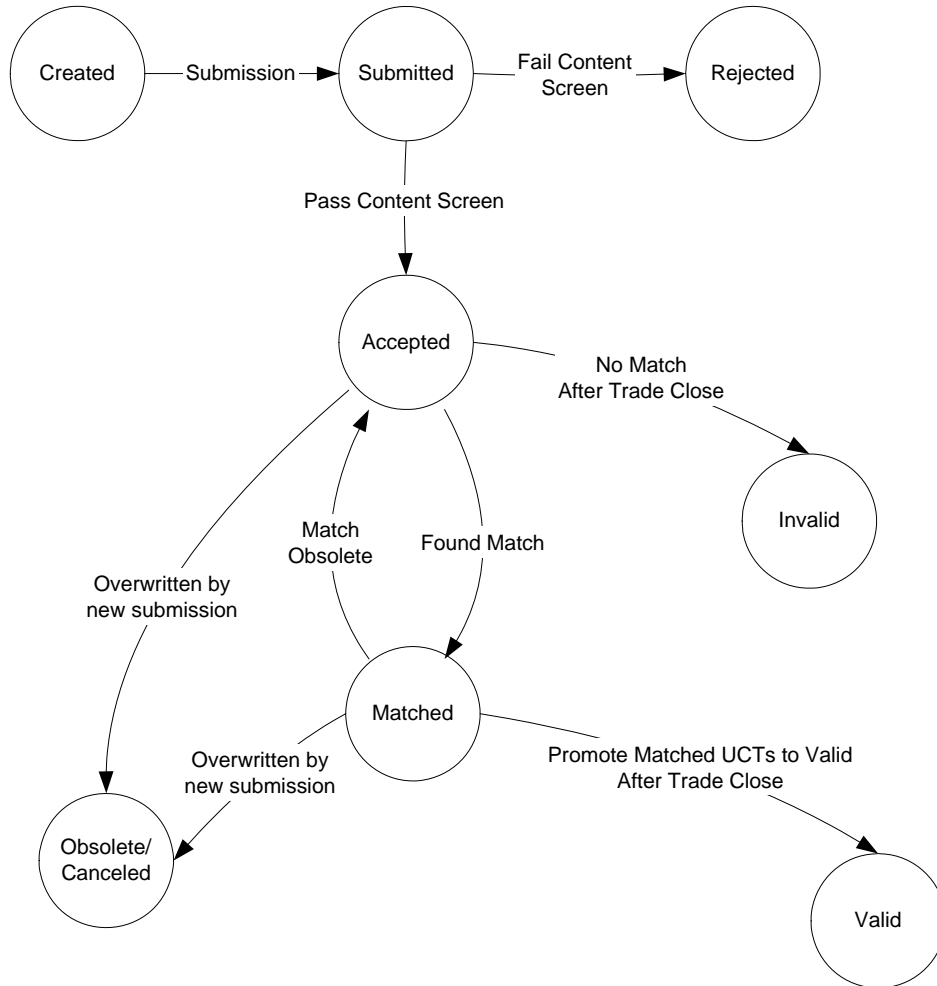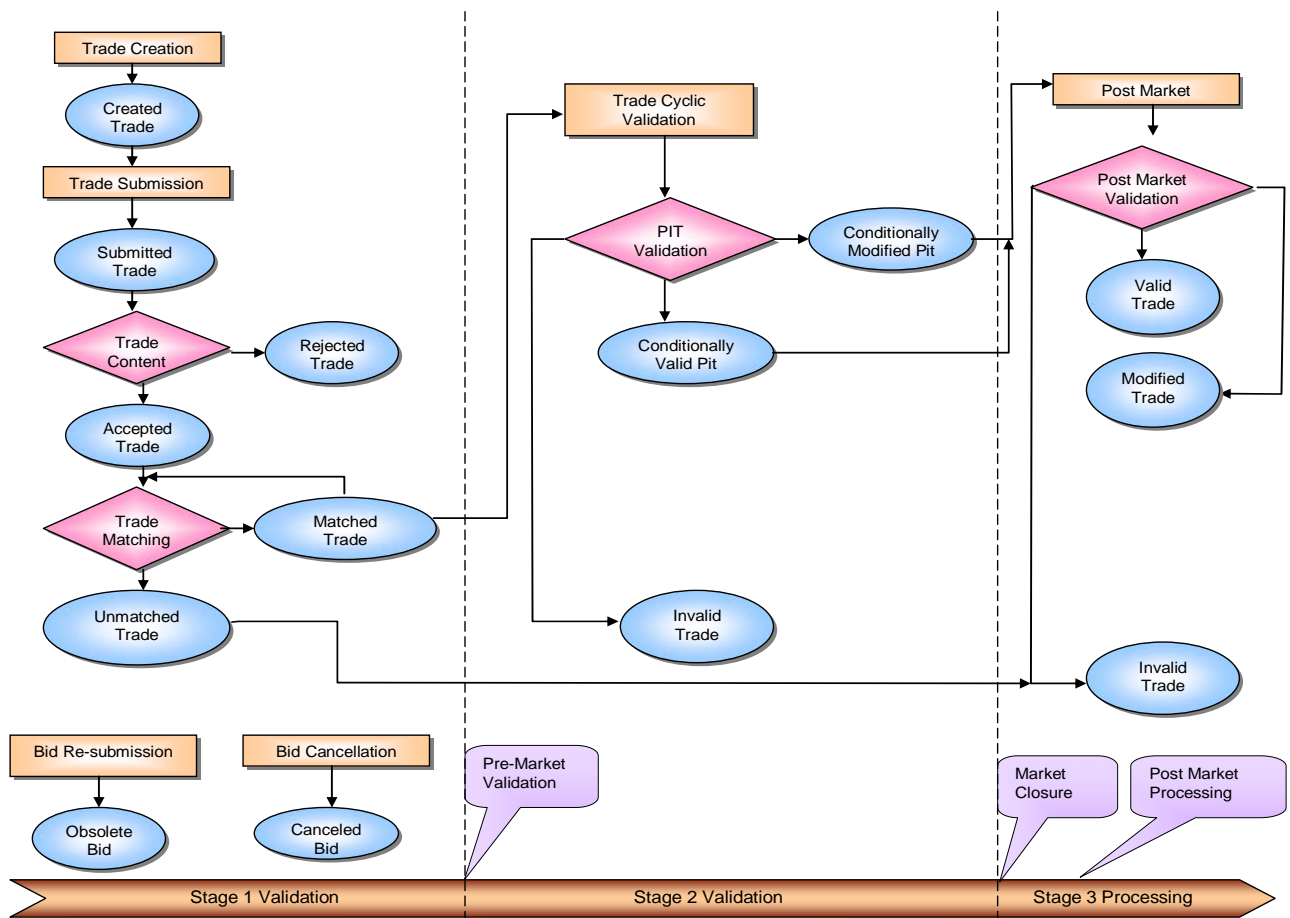An UCT experiences in the validation process the following states as shown in Figure 13.

Figure 13 State Transition Diagram of UCT

6. Reference

[1] Peter Pin-Shan Chen, "The Entity-Relationship Model-Toward a Unified View of Data," *ACM Transactions on Database Systems*, Vol. 1, No. 1. March 1976.

Appendix A - Timeline of Business Events and Validation

The timeline shown is for ISTs but it does not differ much from the AST and UCT timelines. Those two do not include Stage 2 and post market close processing occurs immediate after market close. The following diagram explains the sequence of a Real Time Close. It also shows that timing is based on the Bid close and needs to be provided by a service that is event aware.