29 April 2016

Level 17
197 St Georges Terrace
Perth WA 6000

Postal Address:
PO Box 7096
Cloisters Square
Perth WA 6850

T +61 8 9254 4300
E wa@aemo.com.au

Dr Ray Challen
Deputy Director General
Public Utilities Office
Department of Finance
Locked Bag 11
Cloisters Square WA, 6850

Dear Dr Challen

RESPONSE TO POSITION PAPER: DESIGN RECOMMENDATIONS FOR THE WHOLESALE ENERGY AND ANCILLARY SERVICE MARKET REFORMS

The Australian Energy Market Operator (AEMO) welcomes the opportunity to provide a response to the Electricity Market Review (EMR) Position Paper: Design Recommendations for the Wholesale Energy and Ancillary Service Market Reforms (Position Paper) published on 14 March 2016.

In general, AEMO supports the reforms that have been proposed in the Position Paper. The reforms aim to improve the accuracy of market-based pricing, transparency and the efficiency of dispatch in the Wholesale Electricity Market (WEM). Further AEMO agrees that the reforms will better achieve economically efficient outcomes and therefore help to achieve the Wholesale Market Objectives.

AEMO is supportive of the adoption of market arrangements that are consistent with those in the National Electricity Market (NEM). This will allow AEMO to leverage existing systems, processes and expertise for use in the WEM, albeit with a certain level of customisation for WA specific elements such as the Reserve Capacity Mechanism (RCM), the Short Term Energy Market (STEM) and Demand Side Programmes. Overall the economies of scale may contribute to savings during the implementation phase and over time in operating the market systems.

General support

AEMO considers that a number of the design features proposed in the Position Paper are fundamental to the reform of the WEM and can be expected to deliver efficiency benefits. These include five minute dispatch intervals, later gate closure, ex-ante pricing incorporating the cost of congestion, the co-optimisation of energy and ancillary services, moving the reference node from a generation centre to the load centre and removing the unique arrangements for the dispatch of the Synergy generation portfolio.

Further information about essential reforms are provided below.

<u>Reference node and loss factors</u>

AEMO considers a change of the reference node from its current location at a generation centre to the demand centre to be an essential feature of a network-constrained market design with a single settlement region. The reference node is the point constraints are oriented towards, therefore, with a reference node at a generation site it is not possible to constrain the generation facilities at this node. As a result the price setting is distorted and the limitation to constrain facilities at the reference node creates security management complexity. The reference node is also chosen as the unity loss factor node, with other

nodes' loss factors being set with reference to it. However, this is not expected to have an impact on Market Participants settlement. The change in loss factor adjusted energy quantities will be compensated for by a higher loss factor adjusted price.

Supporting information to shift the reference node to the load centre and an explanation of the changes from a settlement perspective have been attached to this submission in Appendix A.

Ancillary Services

AEMO supports the adoption of the NEM's ancillary service markets and the adoption of tighter, more clearly defined service definitions, along with good faith bidding and rebidding provisions, which apply to both generating units and ancillary service loads in the Frequency Control Ancillary Services markets. Consideration has to be given to whether registration as an ancillary service load will affect the load's ability to be registered to a separate retailer, demand side aggregator or provider of non-market ancillary services.

Due to the relatively low energy price caps in the WEM and the limited number of generators capable of providing ancillary services, AEMO supports retaining obligations for Synergy to be required to offer these services in case the requirements cannot be met.

AEMO also supports in-principle a full runway model to allocate the costs of contingency raise services to Market Participants that contribute to these requirements. Implementation of this methodology would, however, impose a cost to modify AEMO's existing market systems.

Co-optimisation

AEMO considers the introduction of co-optimised dispatch of energy and ancillary services to be a fundamental change to achieve market-based efficiencies. The provision of a more tightly defined scheme will ensure security and systems standards are maintained whilst allowing competition to provide those services. Often the most significant incremental cost to supplying a service will be the generation output that needs to be foregone. Optimisation of energy and ancillary services provides for that to be taken into account in the pricing and enablement of services.

AEMO is able to provide further information on how these services are undertaken in the NEM, including the bidding process, operational impacts and timeframe for co-optimisation. AEMO would also suggest involving Market Participants early on in the design of the bidding process so that they can engage and provide feedback on implementation from an operational point of view.

Further policy guidance

While AEMO supports the general design directions proposed in the paper, we note that the proposed improvements will deliver a significantly different electricity market which will require substantively different support systems. In moving to new arrangements and systems, further policy decisions regarding a number of aspects of the design of the new market and dispatch arrangements are required prior to implementation. In particular, AEMO will need early advice on the following issues below.

As Generated vs. Sent Out dispatch

AEMO considers it appropriate to retain the current hybrid arrangement where, As Generated and Sent Out dispatch are both utilised in the WEM. This is consistent with arrangements in the NEM and therefore AEMO's systems and processes can account for the

hybrid. This will ensure that the current commercial outcomes, in particular for Market Participants with embedded generation are retained.

AEMO, does however note that for the purposes of power system security and reliability purposes, it will require access to operational information related to large loads and embedded generation to ensure that it is able to maintain system security and reliability and undertake adequate contingency planning. The potential loss of a generator will be a credible contingency that needs to be taken into account in determining the secure operating level of the network. AEMO understands that the information required, both in the planning and operating timeframes is currently supplied by larger generators 'behind the meter' in most instances in the WEM but recommends that an obligation is specifically included in the WEM Rules.

Settlement cycles

The settlement system currently deployed in the WEM is at the end of its lifecycle. A new settlement system will be designed to give AEMO the maximum flexibility moving forward by performing all calculations on a Trading Interval basis. This will allow AEMO the option to offset the amounts owing and amounts owed to each Market Participant in certain Trading Intervals to compare to their trading limits for prudential purposes and derive weekly settlement values. AEMO supports the move to shorter settlement cycles to align with those in the NEM. The trend in markets internationally is also to shorter settlement cycles to better manage risks.

AEMO notes that moving to a shorter settlement cycle should reduce the amount of prudential support that it would need to hold for Market Participants. However this would need to be supported by changes to the calculation of the Individual Reserve Capacity Requirement (allocation of capacity costs) to allocate the costs across the month rather than at the end of the month.

Matters for consideration

In addition, AEMO considers the following matters, which were not addressed in the Position Paper, need policy guidance as these matters have a direct correlation to the proposed changes recommended in the Energy Market and Operation Processes reforms.

Price caps

AEMO notes that there will need to be consideration of price caps to apply for Ancillary Services bids, and that they will need to be designed to ensure that Market Participants are adequately incentivised to provide these services and take into account the asymmetry between energy and ancillary service prices given that energy prices are supplemented by the Reserve Capacity payments.

AEMO further notes that the current energy price caps are by nature bid caps and not market price caps. In an unconstrained market, this is a moot point but needs consideration within the proposed market arrangements. AEMO considers that further work is required to ensure that appropriate market price caps are developed which cap the market clearing price which includes impacts of any network constraints, ramp rates and co-optimisation of energy and ancillary services. A market price cap will need to be developed to take these factors into account and allow the market to clear under most circumstances without introducing undue price risk.

Outages and provision of availability information

AEMO understands that work to reform the RCM is due to be completed and will result in the introduction of changes to the WEM Rules. The mandate for these reforms is to drive a more efficient balance between supply and demand in the WEM. With the RCM work being finalised, AEMO considers it necessary to reassess the existing concept of outages in light of a network-constrained market design as part of the proposed reforms to the energy and ancillary services markets.

AEMO notes that further work will need to be undertaken to assess the overlap between Reserve Capacity, Outages and constraints. For example, whether the RCM certification or refund mechanism will need to be changed in some way to more inherently reflect the constrained nature of the grid.

It is further recommended the WEM adopt the NEM's definitions of Fast-start/Slow-start and Project Assessment of System Adequacy availability, the latter indicating the availability of uncommitted slow-start units, which can be used for information disclosure and the assessment of RCM availability.

AMEO can assist the PUO in designing more suitable processes around Outages and reporting the availability of generators.

Demand Side Programmes

AEMO understands that the PUO has been working on concepts for Demand Side Programme (DSP) dispatch. This piece of work was not included in the Position Paper. Therefore, AEMO would like to support the PUO's work to design a suitable mechanism for the dispatch of DSPs and market price setting during those periods.

Early feedback into this project will ensure that the new dispatch concept can be integrated into the existing settlement system. It would also be beneficial to engage with System Management to identify potential issues and utilise existing expertise in the current DSP dispatch process.

Power System Security and Reliability

With the proposed repeal of the Technical Rules under the PUO's Network Regulations work stream, there is an opportunity to review equivalent arrangements in Chapter 4 of the NER for inclusion in the WEM. In particular, AEMO considers it necessary to provide clarity around the obligations of a Network Service Provider with regard to maintenance of power system security and reliability. In addition, enhancement of existing system statuses (i.e. Normal / High Risk / Emergency Operating States) to be more in line with Secure / Satisfactory arrangements under Chapter 4 of the NER would provide AEMO with a more suitable framework and more certainty to make dispatch decisions. The specification of these requirements is necessary before network constraints are developed.

AEMO considers that Network Service Providers should also be required to consider any market-based costs, including for example constrained on payments, in their assessment of network augmentation investment decisions related to their network reliability requirements.

General comments

AEMO has focused its consideration of this Position Paper in the context of the new market arrangements to apply from 1 July 2018. There are transition matters which need to be addressed in the operation of the existing market. An example of this are the imminent

changes to the Reserve Capacity Mechanism which will need to be reflected in revised dispatch arrangements in the Balancing Market and refund arrangements in settlements.

Further consideration needs to be given to the need for transitional changes to arrangements. AEMO suggests to consider how each of the EMR reform packages being progressed under the numerous work streams depend upon, for example the new market arrangements and the changes to network regulation and institutional arrangements. These work streams are inter-related and have potential impacts on how AEMO will implement the reforms.

AEMO has developed and provided in support of the Position Paper, a preliminary end-to-end market system design based on the proposed wholesale and retail market design to be implemented for 1 July 2018 which has been attached to this submission in Appendix B. The proposal leverages national systems and processes to the extent possible. It should be noted that this proposal is based on the policy decisions that have been made to-date and AEMO's assumptions about other critical inputs. This proposal therefore represents AEMO's preliminary approach, which will necessarily be updated as more information is provided by the PUO. AEMO intends to engage with stakeholders on the finalisation of this proposal and sees it as a vehicle for discussion on the key features of the new market design.

If you would like to discuss any matters raised in this submission, please contact Erin Stone, A/Group Manager, Markets (WA), on (08) 9254 4304 or by email: erin.stone@aemo.com.au.

Yours sincerely

David Swift

Executive General Manager - Corporate Development

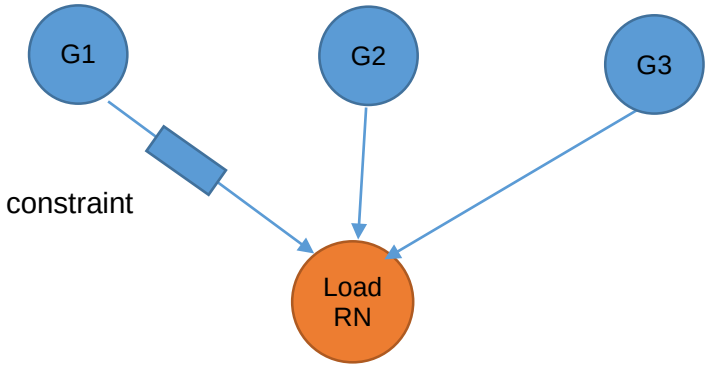
29 April 2016

Appendix A: Move of reference node

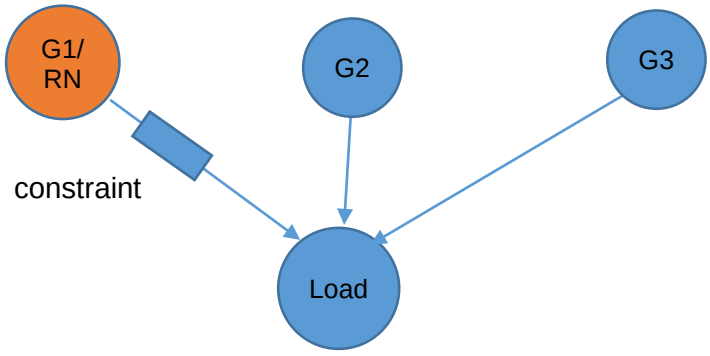
The Position Paper seeks comment on the likely effects of the change of the reference node to a location in Perth (pg. 50).

Constraint representation

AEMO concurs with the philosophical, practical and equity based reasons listed but goes further. We consider that a load-centre based reference node (RN) is an essential feature of a network-constrained market design with a single settlement region. In such an arrangement, the dispatch engine operates with the network represented in a “hub & spoke” model. Generators are represented by the spokes, whilst the aggregated load is represented by the hub.



In this standard hub and spoke design, the capacity for each generator’s output to be dispatched is limited by a constraint equation of a form such as G1 ≤ constraint. By orienting the constraints in this manner, the shadow price of the supply equals demand constraint (i.e. G1+G2+G3 = Demand) and will identify the true marginal cost of meeting the last increment of demand at the load centre. This design ensures that all scheduled generators are directly controlled by the dispatch engine, enabling the network to be managed as securely as possible.



If the reference node is located at a generator, then constraints must be oriented towards it, meaning G1 cannot appear in a network constraint equation. Thus congestion between G1 and the load must be managed as G2+G3-Load ≥ –Constraint. This representation cannot

directly control G1, and results in the settled price equalling G1's marginal bid price, and G2 and G3 being constrained on.

This creates security management complexity, and sets incorrect price signals for the load and region generally.

Loss Factors

For regional pricing accuracy, the reference node is also chosen as the unity loss factor node, with other nodes' loss factors being set with reference to it. In the WEM and NEM however, all settlements are nodally loss factor adjusted, which means in effect the reference node's location is redundant in settlement. I.e. settlements remain the same.
In the second diagram above, G1's loss factor would be 1.00, but with the reference node moved to the load centre, its loss factor appears to fall, to, say 0.98.
However its settlement would be unchanged: the load centre based regional price would now become 2% higher, and after adjusting for loss factors, G1's settlement would be unaffected by the move

The table below shows the settlement prices and quantities pre and post shifting of the RN for a generator with a capacity of 100 MW and a bid price of $100/MWh, and is the marginal generator on the system.

	RN at G1	**RN at Load Centre**
Loss factor (LF)	1.00	0.98
Bid price	$100/MWh	$100/MWh
LF adj. bid price	$100/MWh / 1.00 = $100/MWh	$100/MWh / 0.98 = $102.0408/MWh
Energy quantity	100MWh	100MWh
LF adj. energy quantity	100MWh * 1.00 = 100MWh	100MWh * 0.98 = 98MWh
Settlement amount	100MWh * $100/MWh = **$10,000**	98MWh * $102.0408/MWh = **$10,000**

Appendix B: Market Systems Proposal

This appendix presents an architecture assessment and suggested approach for market systems to support AEMO's reformed Western Australia Wholesale Electricity Market (WEM3) from July 2018.

This proposal document sets out the high-level requirements and some key assumptions and then provides the architecture and systems design proposed to implement the proposed market reforms. The approach is based on a single scenario "best guess" basis of the most likely outcomes of the market reform process based on the draft Position Papers and discussion with the EMR. The primary assumption is that AEMO's existing software assets can be leveraged and deployed to support WEM3.

Although this proposal is being submitted to the Wholesale Energy and Ancillary Service Market Reform Position Paper, in AEMO's view the systems to support this workstream will be highly integrated with other workstreams.. Therefore these proposals consider the entirety of AEMO's role in the WEM3.

Some key assumptions are:

- AEMO will have a WA control room.
- AEMO will have a WA data centre to host highly available systems locally
- There is a reasonable functional fit between NEM and WEM3 such that only limited software customisation is required.
- Subject Matter Expert (SME) resources will be available to complete the project work.

A preliminary analysis of the resources required to implement the systems proposal and work is underway to develop a more detailed plan. This estimation is limited by the lack of detail on the target state of WEM3 and therefore requires assumptions to fill knowledge gaps.

While a plan cannot be finalised until the full requirements are known, it is clear that this is a substantive project that will require considerable skilled resources to complete and that it would take 18 months to successfully deliver the project. Taking into account the need to allow time at the completion of the systems development and implementation to allow participant testing and trials, it will be critical to expedite the final design and approval to commence.

1 References

1.1 Key Documents

The following documents are useful for understanding this requirements description.

Name	Description	Location
Western Australia Energy Market Review	Specification outline	WA Energy Market Review
Information Paper: Full Retail Contestability Project		Information Paper: Full Retail Contestability Project
Information Paper: Removing Barriers to Entry Project		Information Paper: Removing Barriers to Entry Project
Information Paper: Reserve Capacity Mechanism		Information Paper: Reserve Capacity Mechanism
Information Paper: Energy Market Operations and Processes Project		Information Paper: Energy Market Operations and Processes Project

1.2 Abbreviations

Abbreviation	Explanation
FR	functional requirement
NFR	non-functional requirement
NA	not applicable
COTS	Commercial off the shelf
SaaS	Software as a Service

1.3 Special Terms

Term	Definition
WEM	Wholesale Electricity Market
NEM	National Electricity Market
FRC	Full Retail Competition
MSATS	Metering, Settlements and Transfer Solution
EMR	WA Electricity Market Review
STEM	Short Term Energy Market
RCM	Reserve Capacity Mechanism
SWIS	South West Interconnected System

2 Background

2.1 Need for New Systems

The proposed changes to the WEM and the formation of a combined Independent System and Market Operator is a major step in the evolution of that market. The greater emphasis on the real time market, the introduction of 5 minute dispatch, the inclusion of network constraints into market dispatch and pricing and the move to ex-ante pricing mean that the existing market systems will not be adequate nor capable of enhancement to meet these design objectives.

The final design will maintain a Reserve Capacity Mechanism (RCM) and software servicing the existing RCM would be retained, enhanced and linked to the total market and settlements package. The Short Term Energy Market (STEM) system will also be retained, however will require enhancements and integrations. Other than these two items, the balance of the system for the reformed WEM will need to be new to WA.

2.2 High Level Brief

2.2.1 Objective

To provide the architecture and an outline of the systems required to support a reformed WEM market for a 1st July 2018 commencement.

This proposal document focuses on the latter 3 workstreams of the WA Electricity Market Review, i.e. Market Competition, Institutional Arrangements and Wholesale Electricity Market Improvements and in particular the high level requirements and assumptions that would underpin a systems deployment to support the proposed market reforms.

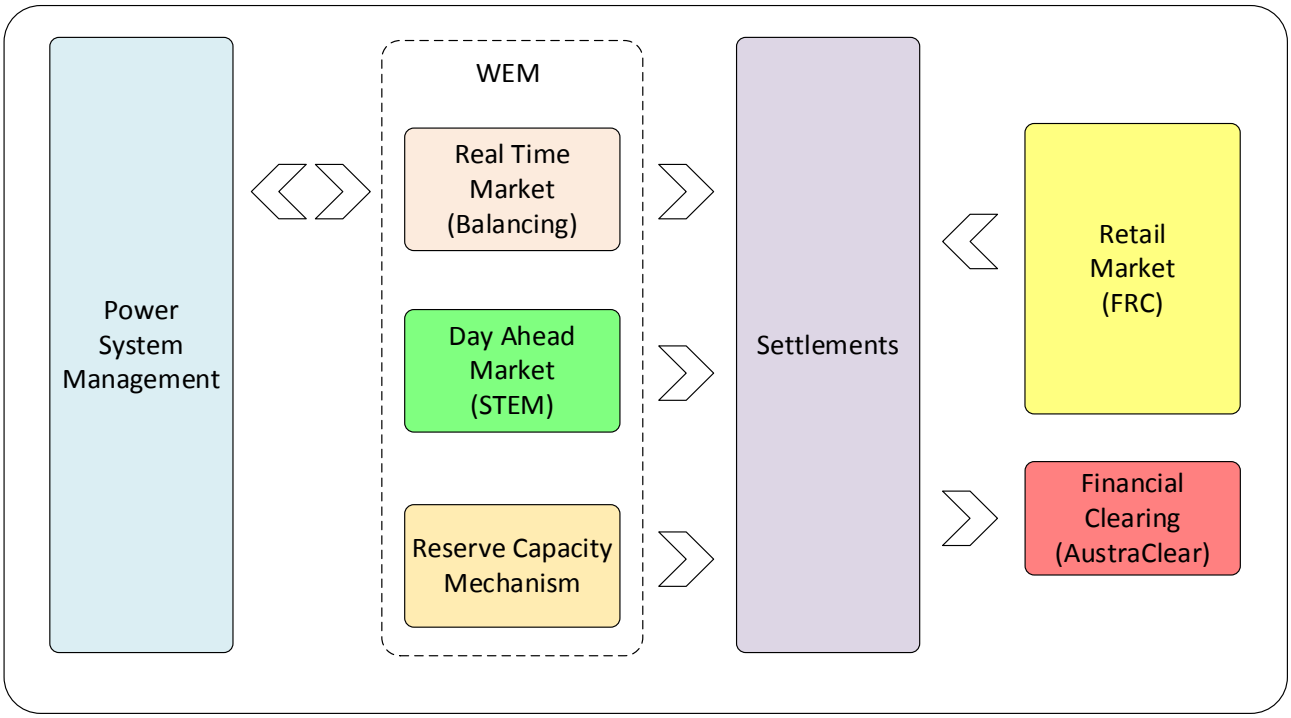
2.2.2 Assumptions and Constraints

The key assumptions, constraints and limitations of this estimation include:

- The design of the reformed WA electricity market is yet to be finalised. The proposal is based on a single scenario ‘best guess’ basis of the most likely outcomes of the market reform process based on the Position Papers and discussion with the EMR and, in particular, the Position Paper on “Design recommendations for the wholesale energy and ancillary service market reforms”.
- AEMO’s market systems are considered well suited to the design requirements of WA so this proposes an ‘end-to-end’ solution based on using AEMO’s existing systems supporting the NEM to support the WEM markets to the extent possible.
- Low risk approach – minimise requirement for software customisation.
- The proposal needs to be reassessed when the WA Electricity Market Review process delivers the final recommendations concerning forward market structures and full project plans would need to be developed at that time.

3 WEM Market Overview

The WA electricity market reform is not yet finalised, but the high level functional areas expected from a WEM3 market include:



It is expected that of each of these capabilities will be in place to support the commencement of the WEM3 market on 1st July 2018.

Each of these functional areas is discussed in further detail below, and where appropriate existing capabilities are identified and mapped to the anticipated WEM3 market requirements.

3.1 Power System Management

The Power System Management capability includes all those elements required for effective management of grid security within the WA South West Interconnected System (SWIS).

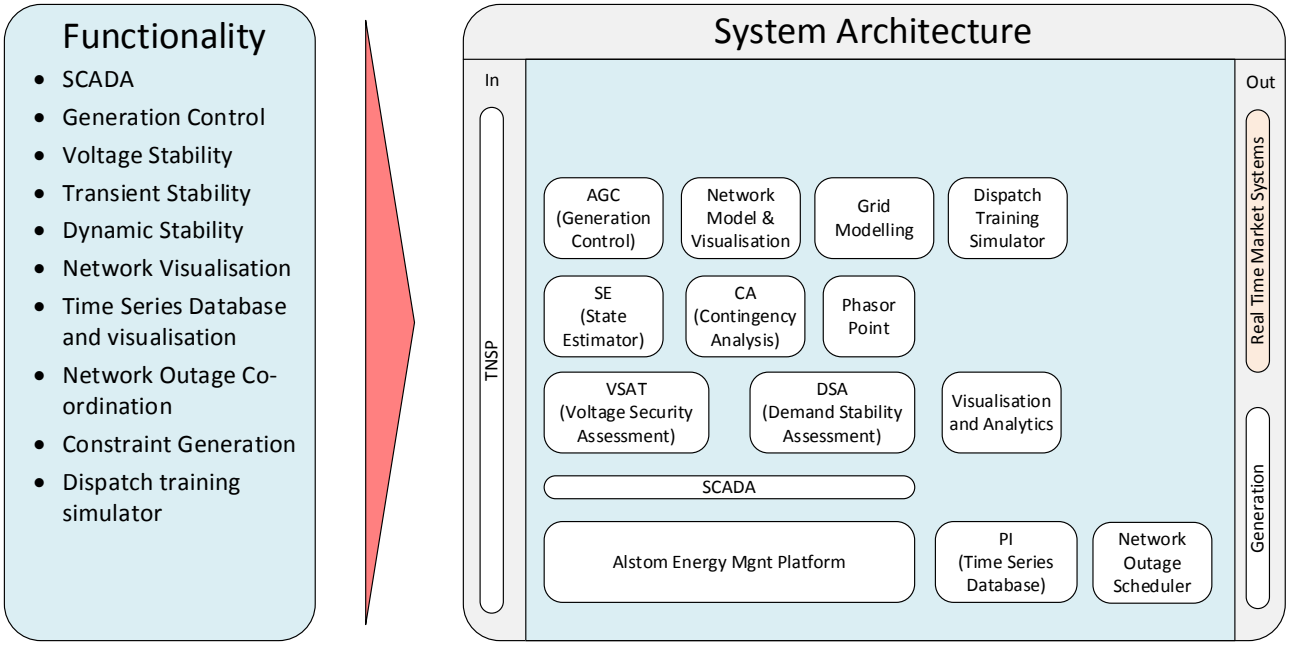
Currently AEMO is responsible for the System Management function on the east coast grid. The responsibility for System Management of the SWIS will be transferring from Western Power to AEMO in the near future. At the commencement date of the WEM3 market, additional functionalities such as generation control functionalities will also be required to support the Real Time Market.

AEMO will retain a control room in WA that is dedicated to the management of the SWIS. The WA control room operators will require access to a highly available platform in order to effectively manage supply and grid security.

Power System Management is a reasonably generic requirement. From a systems perspective, there is a broad range of commercial off the shelf product offerings from specialist software vendors. AEMO has significant sunk investment in the Alstom platform, which is used to service the east coast grid. AEMO proposes that the preferred model to service SWIS would be to extend the Alstom platform with a local WA node and then to commission redundant network links between the WA data centre, AEMO's Norwest data centre and the WA control room to support that system and ensure high availability. Other alternatives such as servicing SWIS solely out of the SCADA/EMS platform in both east coast data centres was not assessed as whilst such an option is technically feasible, it is outside the high level constraints.

In terms of the Alstom platform currently servicing the NEM, there is already quite a range of modelling diversity in the power system elements, so it is expected the Alstom platform should largely accommodate the functional SWIS requirements on an as-is basis. AEMO has already successfully completed a project to consolidate the Victorian gas SCADA into the Alstom platform, so this could be a model for how the SWIS could be integrated.

The high level overview of the systems proposed to support the Power System Management capability is shown below:



It is not expected that the SWIS network will require the full range of network application capabilities that are presently available in the Alstom platform, as the SWIS network does not necessarily exhibit characteristics

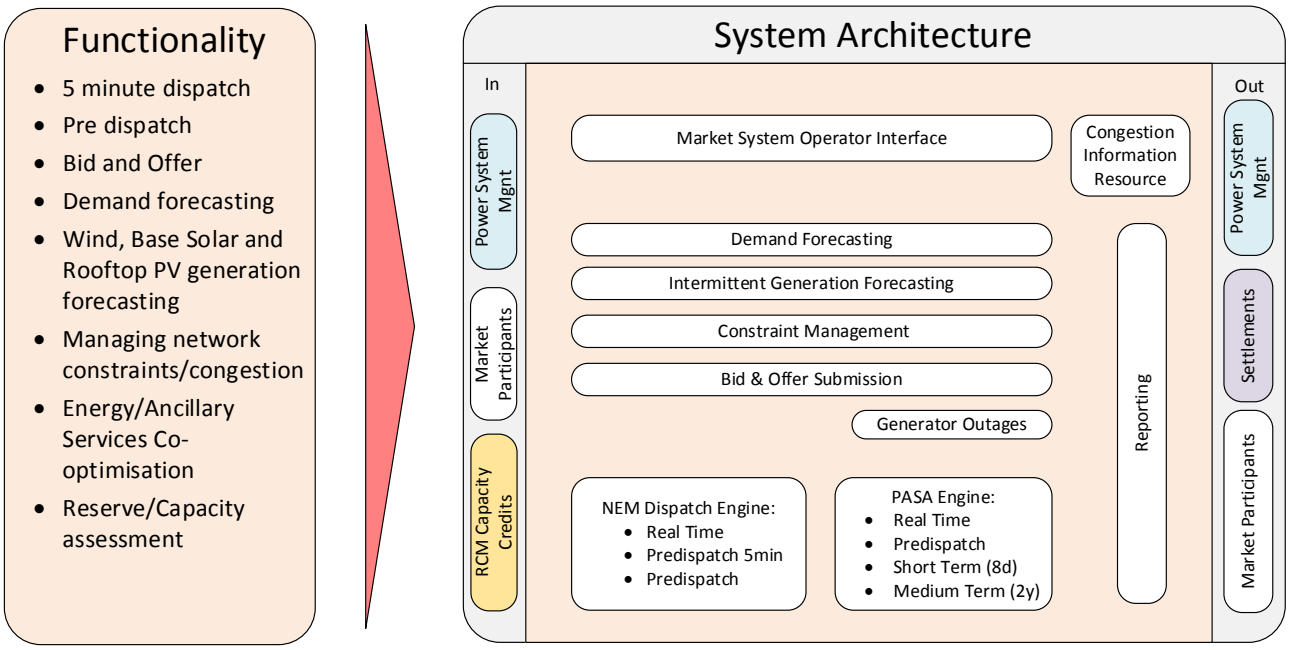
that would require stability assessment across a range of technical domains. Nonetheless, it is reassuring that these capabilities are an inherent part of AEMO's Alstom platform and this provides a level of assurance that should new problems emerge as an outcome of system augmentations, then the underlying platform would be equipped to enable additional capabilities.

3.2 Real Time Market

The Real Time Market capability includes all those elements required for security constrained economic dispatch operating in short timeframes. The Real Time Market in WEM3 is expected to perform a balancing function on a 5 minute cycle, dispatching generation to ensure supply meets demand. It is also expected to be responsible for dispatch of on-market ancillary services which are to be co-optimised with the energy market outcomes.

It is anticipated that a range of forward looking processes largely mirroring the NEM such as Predispatch forecasts will be required to provide the appropriate market price signals to participants so they can interact with the Real Time market.

The high level overview of the systems proposed to support the broader market management capability is shown below:



It is worth noting that a range of supporting system services are required to facilitate the real time market clearing function. Key inputs include demand forecasting and intermittent generation forecasting. These subsystems will also be required.

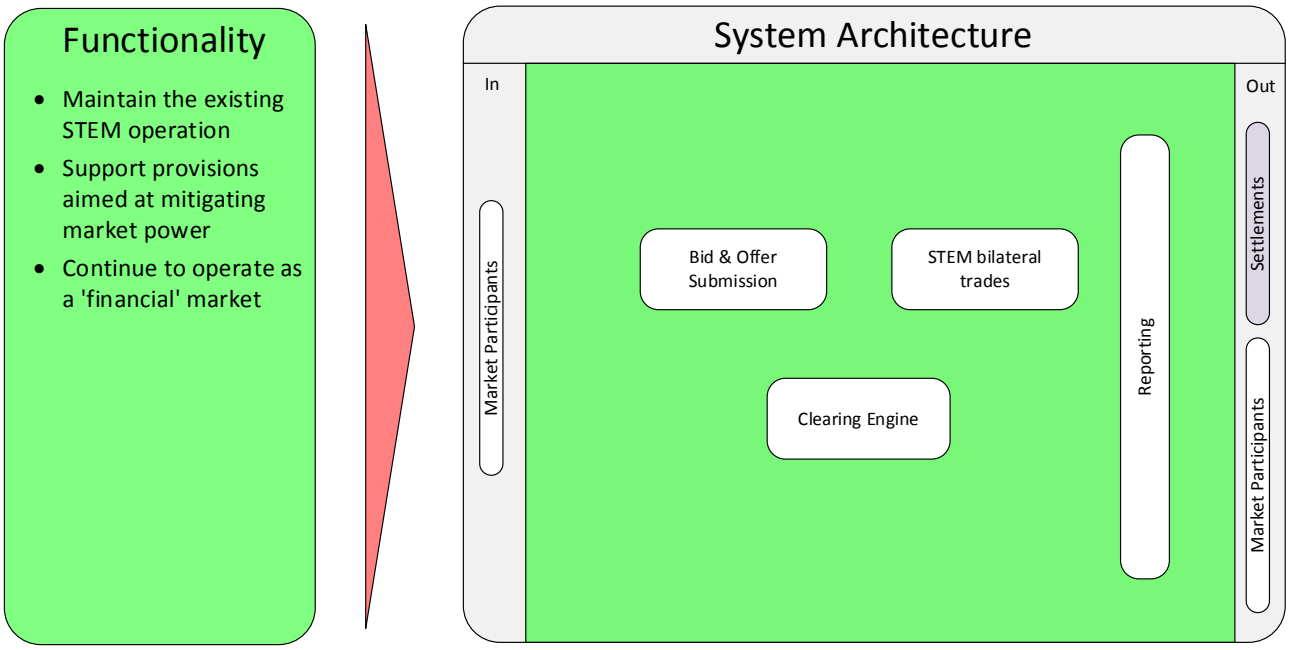
The NEM systems also include a suite of tools (PASA) that are used as a forward indicator of system reserve management. These tools are used by System Operators, but also generate a range of market signals such that the unit commitment decisions made by plant owners can be made within an overall system adequacy context. In the 2 year horizon, it is expected this will be largely managed by the Reserve Capacity Mechanism, but the shorter range PASA assessments will be required for WEM3.

3.3 Day Ahead Market

The Day Ahead Market capability includes those elements required to allow participants to trade and secure their financial position ahead of the real-time market. It also provides a vehicle to notify bilateral agreements and to have them settled through the central market clearing mechanism.

The existing STEM market software servicing WEM will be retained, and integrated with the common Settlements platform. Some work will be undertaken on the STEM software to ensure it remains supported and to facilitate integration. Further integration will also be required to centralised Registration and work will be required to unify participant interfaces (browser and batch data exchange) across all the WEM3 market elements. It is considered that consolidation on both infrastructure and hosting should also be undertaken.

The high level overview of the STEM system proposed is shown below:



3.4 Reserve Capacity Mechanism

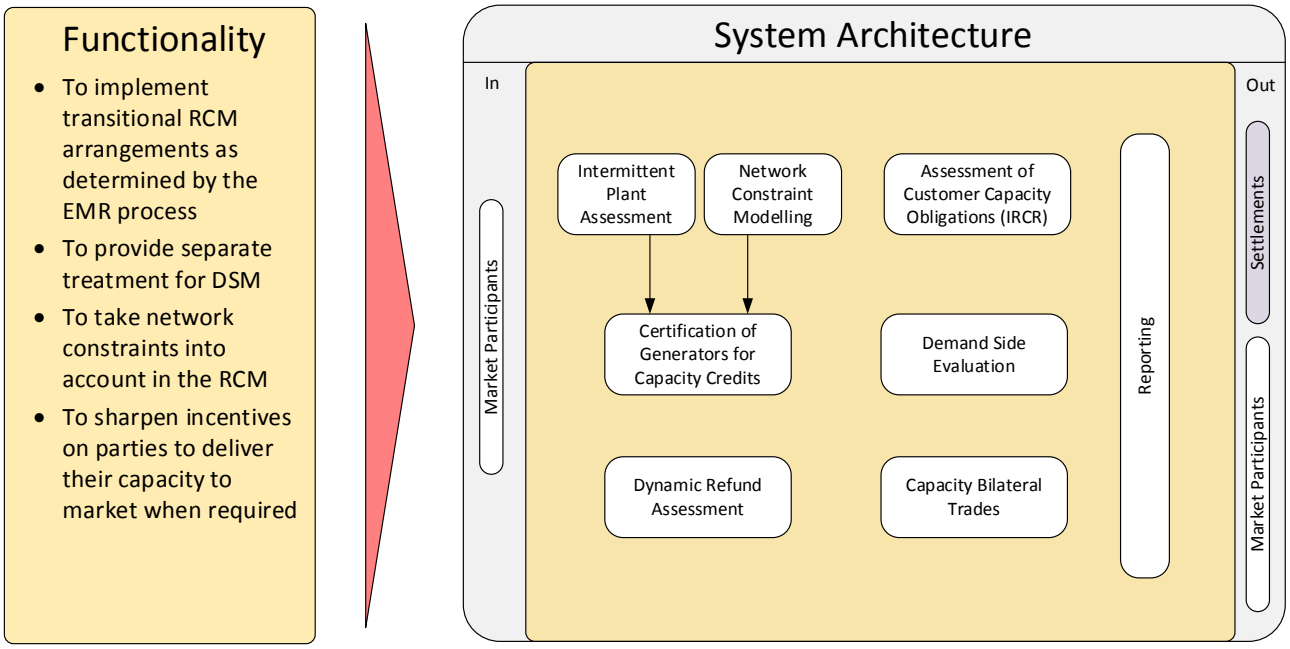
The requirements to support the Reserve Capacity Mechanism (RCM) require further consideration with transitional changes currently underway and an auction process to be implemented in the future. Key elements of the mechanism are determined in the RCM cycle through existing desktop systems and this is proposed to continue. These systems are currently being modified to meet immediate needs of the deferred 2015 cycle.

For the WEM3 market, there will be further interactions required to implement a 'dynamic refund' approach and to move to weekly settlements. Participants who have been provided with capacity payments then have an obligation to offer that capacity to the STEM and real time markets unless they have obtained prior approval for an outage. Where they have not met their obligations under the RCM, they will be required to refund part of the capacity payment they have received.

Current proposals are that capacity provided by the demand side will do so under different arrangements in the future. Provisions for their dispatch, and pricing during dispatch will need specific procedures but it is not clear whether they will require changes to the market systems.

The need for systems to support these requirements has not yet commenced as their detail is subject to the final design chosen. This proposal is based on providing some basic elements which will need to be in place to capture and transactions within the RCM. Given the effort that is likely to be involved with integrating the RCM elements of WEM and IP issues associated with the existing platform, it is suggested that a new build of a basic system should be considered.

The high level overview of the Reserve Capacity Mechanism system proposed is shown below:

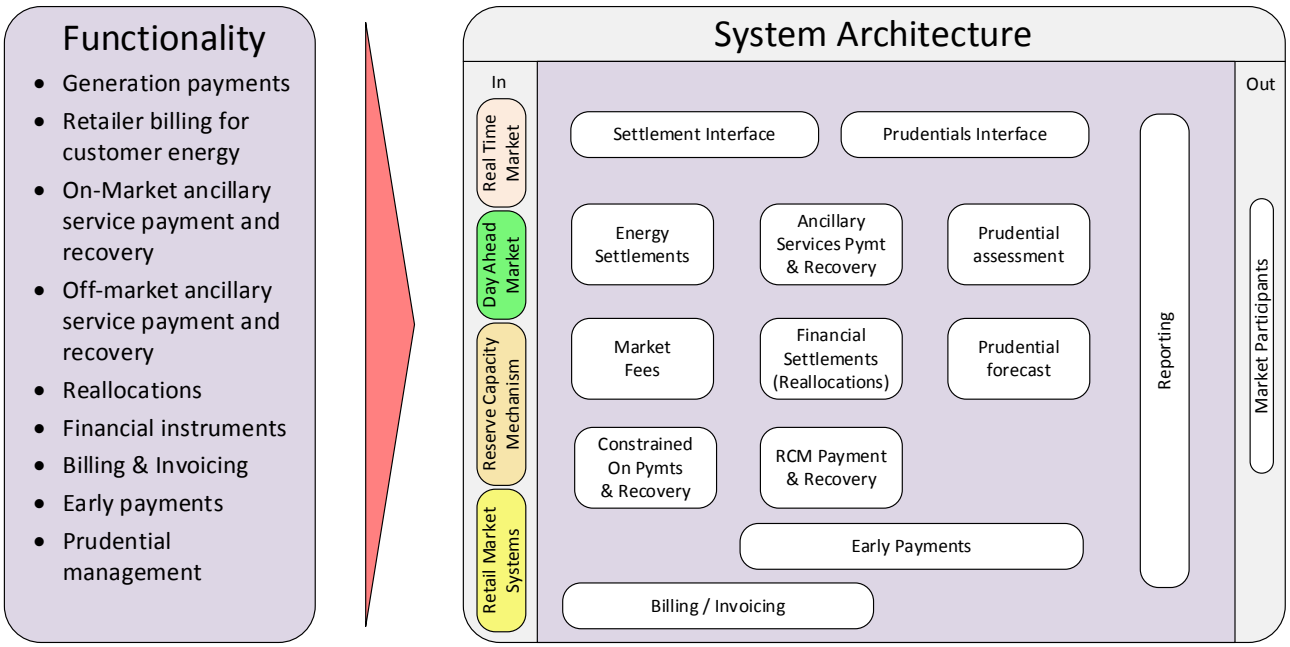


3.5 Settlements

The Settlements capability includes those elements required to calculate market transactions, generate settlement invoices, and manage prudential risk when liabilities are accrued.

The WEM3 settlements system will be a common clearing and prudential management platform for the various market mechanisms within WEM3. It is expected that WEM3 settlements will be conducted on a weekly settlement cycle, four weeks in arrears, similar to the NEM.

The high level overview of the Settlement system proposed for the WEM market is shown below:



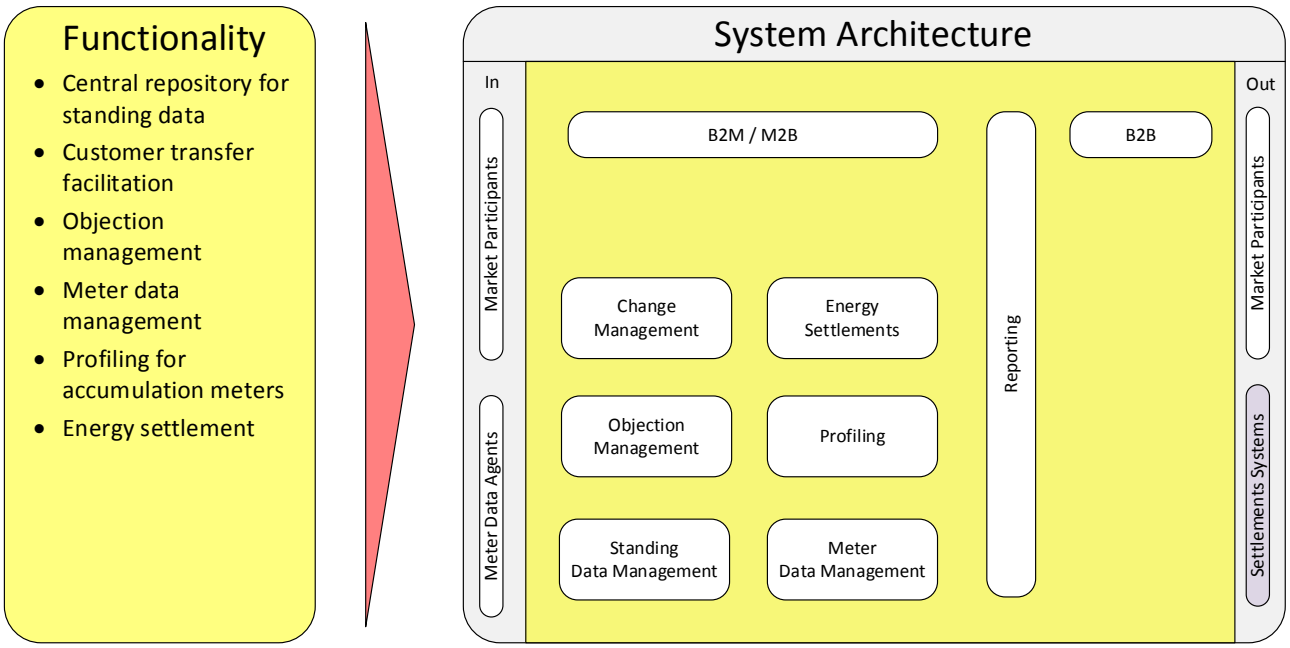
It is expected that the many of the WEM3 transaction types such as generator payments, customer billing, and perhaps fee recovery mechanisms will very much mirror the NEM design. However, it is also likely that there may be some unique requirements originating from WEM3, so it is anticipated that elements of customisation will be required.

3.6 Retail Market

The Retail Market system design is based on providing the capability to support Full Retail Competition (FRC) although it is recognised that the final decision on extending competition to a wider group of customers has not yet been formalised, especially in terms of the nature and timing of any changes.

The intention is to use the east coast FRC market as a model and largely adopt the market rules and standards to provide a robust and tested system which will also minimise the barriers to entry.

The high level overview of the retail system proposed for the WEM market is shown below:

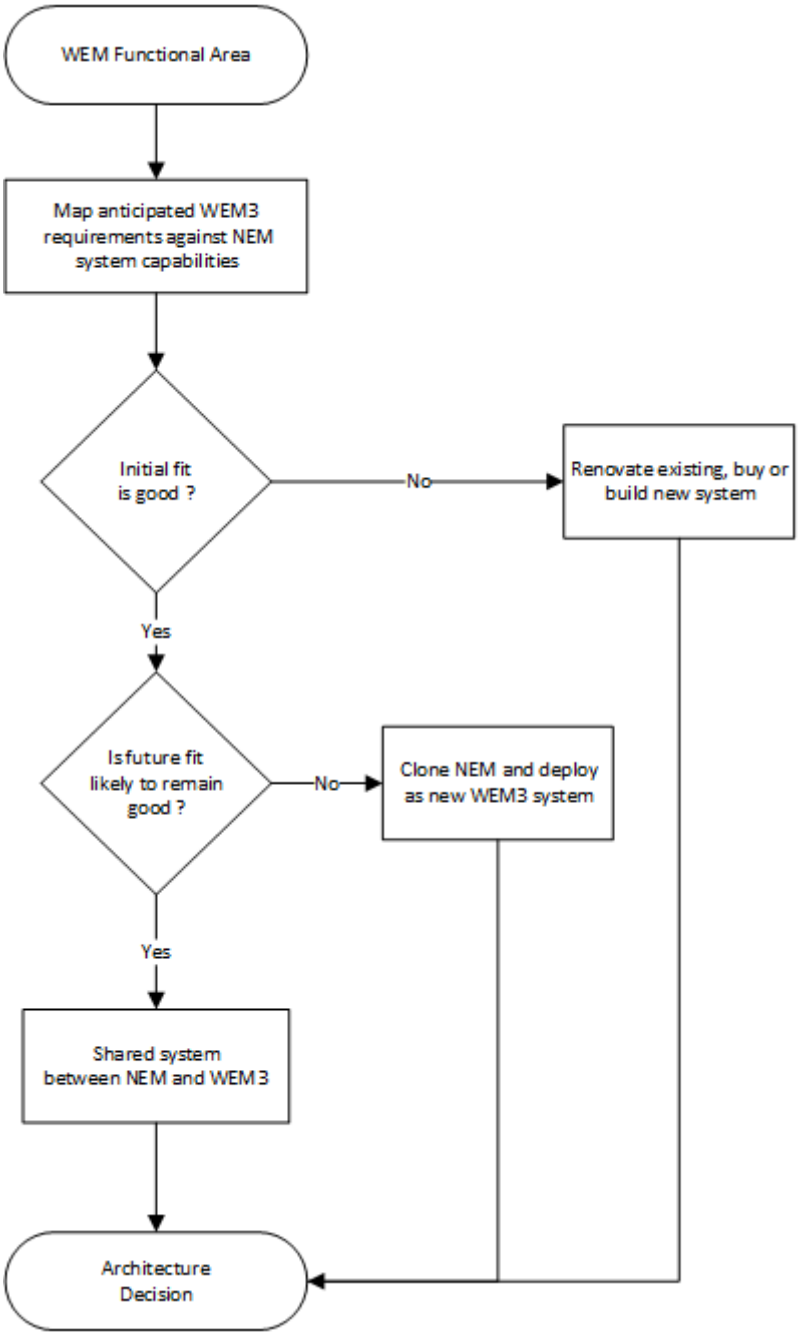


The MSATS system has within it a flexible model for defining jurisdictional based rules. This means that it is possible within the constructs of the existing system to accommodate some specific features for Western Australia. Whether the final WEM3 market rules are within this capability will not be known until the detail of the market rules for WA firm.

4 Conceptual Design

4.1 Approach

The general approach to the high level conceptual design is as follows:



The assessments for each of the WEM3 functional areas is included in Attachment 1.

The summary of those assessments is in the table below.

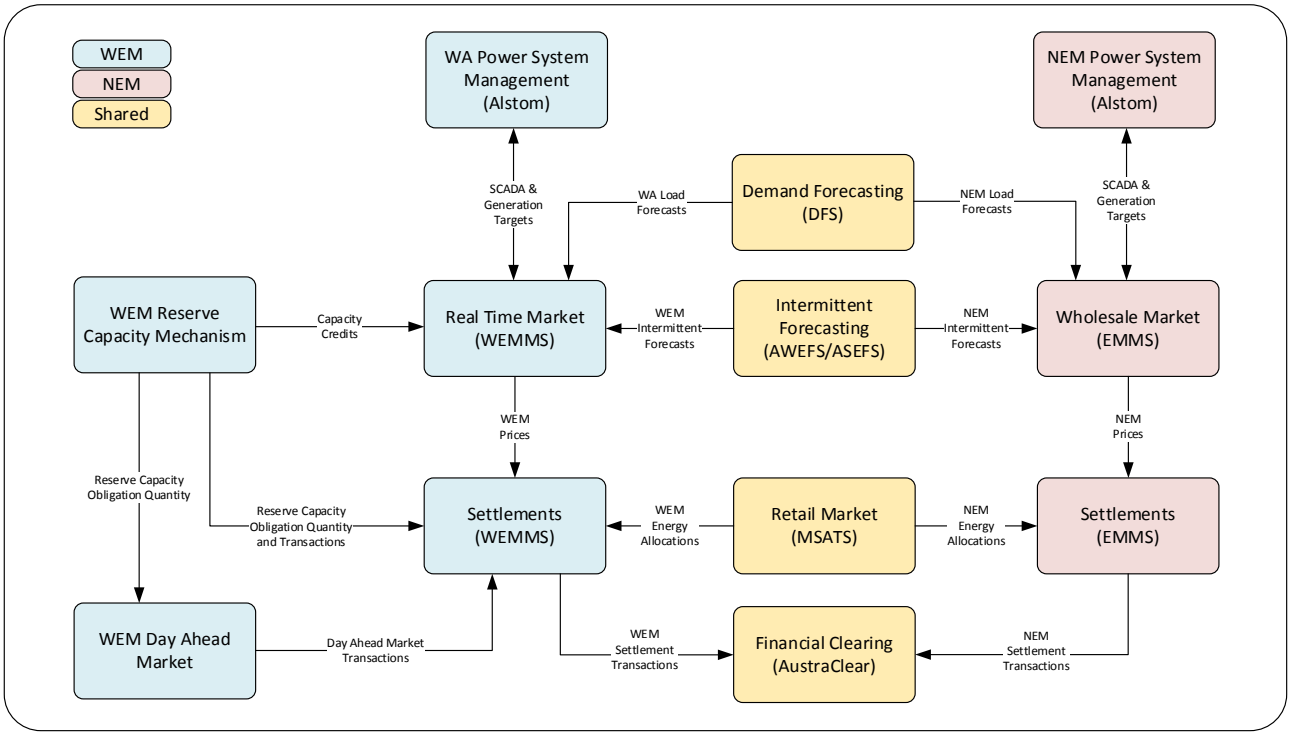
System	Functional Alignment				Decision
	Area	Risk	Impact	Primary Impact Area	
Power System Management	Initial	LOW	HIGH	COST	SHARED[1]
	Potential to diverge	LOW	MEDIUM	TIME	
Real Time Market	Initial	MEDIUM	HIGH	FEASABILITY TIME COST	SEPARATE
	Potential to diverge	MEDIUM	MEDIUM	COST	
Day Ahead Market	Initial	LOW	LOW	COST TIME	RETAIN
	Potential to diverge	LOW	LOW	COST	
Reserve Capacity Mechanism	Initial	LOW	LOW	COST TIME	RETAIN
	Potential to diverge	LOW	LOW	COST	
Settlements	Initial	LOW	MEDIUM	COST TIME	SEPARATE
	Potential to diverge	MEDIUM	MEDIUM	COST	
Retail Market	Initial	LOW	LOW	COST	SHARED
	Potential to diverge	LOW	LOW	COST	

Note that the NEM Real Time Market system has functional dependencies on other system services, Those subsystems have been assessed and shown as independent systems in the overall functional architecture.

[1] Whilst it is technically feasible to share the Power System Management platform, the desire for a local installation requires a new instance of the AEMO Alstom platform to be stood up in the WA data centre

4.2 High Level Design

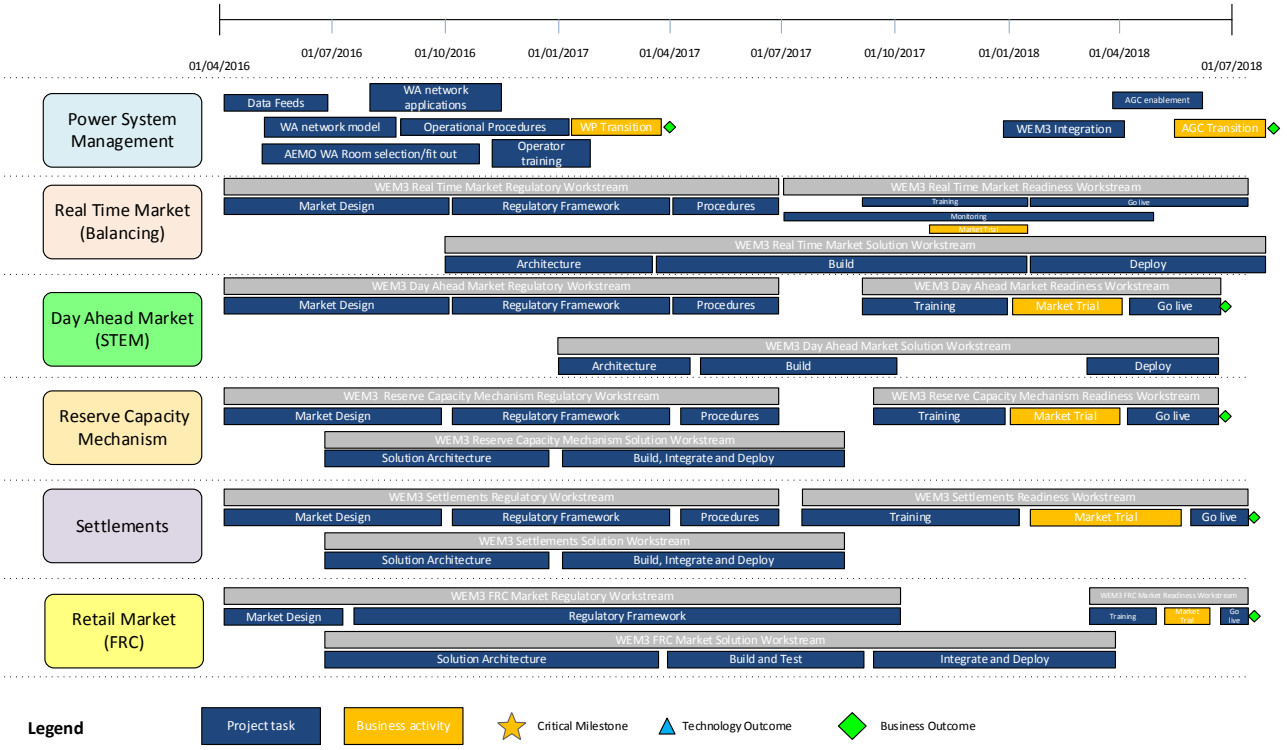
The high level conceptual design of the systems landscape supporting the NEM and WEM3 markets based on the earlier assessments is shown below.



This proposal assumes that the above diagram depicts the target state.

4.3 Timeframe

The following indicative timeframe has been developed based on the anticipated high level scope and assumptions elsewhere in this document.



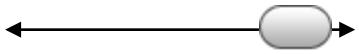
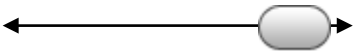
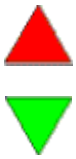
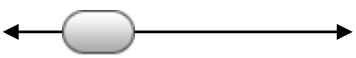
The following notes apply:

- These timeframes represent a single high level conceptual design only
- The timeframe will need to be re-assessed when agreed Business Requirements have been completed.
- The indicative timelines have made assumptions about pre-requisite items of work in the regulatory workstream, the outcome of which may greatly impact both scope and timing of the IT solution workstream.

4.4 Cost Drivers

The real time market is by far the largest contributor to overall cost. There are quite significant line items in this cost estimation associated with highly available infrastructure to support the 5 minute market to the same sort of service levels as the NEM. It has been assumed that separate infrastructure will be required for WEM3 as that market will operate in a different time zone and will require modified versions of the line of business applications that presently support the NEM such that these can be properly aligned to the WEM3 market rules.

The Power System Management is also a significant contributor but it is worth noting that the major line item in this estimation is the fit out of an AEMO WA control room. The following table sets out some of the key cost drivers and levers that are available in order to influence overall project cost.

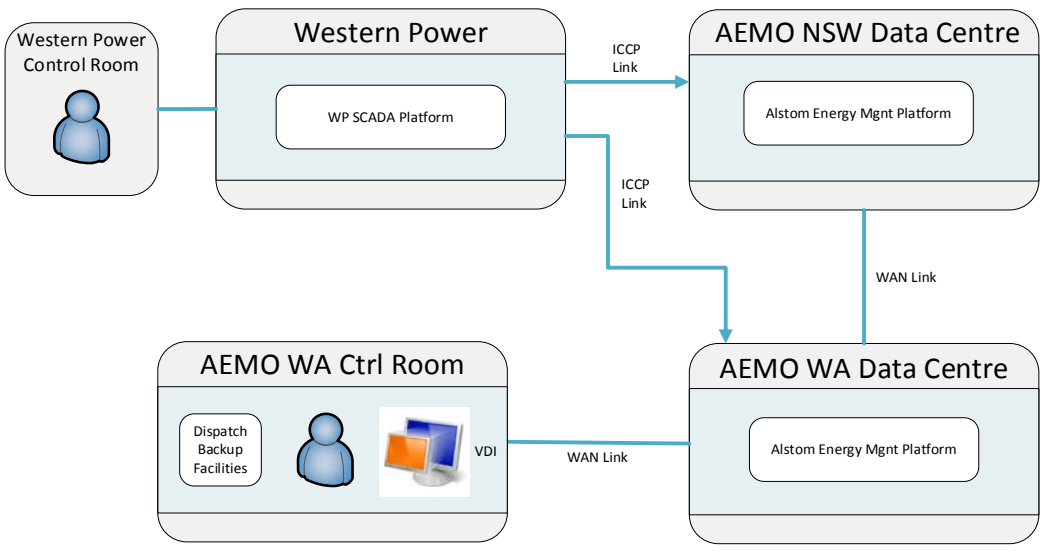
Driver	Budget cost estimate impact			Impact type	Lever
Regulatory Reform outcomes	SMALL		LARGE		The closer the WA market reforms align to the NEM rules, the closer will be the functional fit of AEMO's existing software assets and lowers software customisation effort. Market design which deviates from the NEM have the potential significantly change cost profile.
Resourcing	SMALL		LARGE		A requirement to resource via contractors in lieu of FTE will significantly change cost profile
Control Room Fitout (Power System Management)	SMALL		LARGE		Contingent on level and cost of fitout deemed necessary.
Infrastructure costings (Real Time Market)	SMALL		LARGE		Removing requirement for PASA or accepting lower level of service which may be acceptable for a balancing market may allow a smaller systems footprint. Removing functionality from systems may potentially be at the expense of necessitating manual processes.
Infrastructure costings (Settlements)	SMALL		LARGE		Have been estimated separately however could be shared with the Real Time Market system if both options are taken up

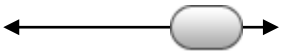
Attachment 1

Assessment of individual workstreams.

B.1. Power System Management

The assessment for Power System Management workstream is shown below:

<table>
<tr><th colspan="5">Power System Management</th></tr>
<tr><td rowspan="3">Functional overview</td><td>Mandatory</td><td colspan="3">SCADA
Generation Control
Network Visualisation
Time Series Database and visualisation
Network Outage Co-ordination
Contingency Analysis
Dispatch training simulator</td></tr>
<tr><td>Recommended</td><td colspan="3">Voltage Stability
Transient Stability Dynamic Stability
Constraint Automation</td></tr>
<tr><td>Optional</td><td colspan="3">PhasorPoint</td></tr>
<tr><td rowspan="2">Architectural Posture</td><td>System Status</td><td>System Complexity</td><td>Technology</td><td>Security</td></tr>
<tr><td>CORE</td><td>MEDIUM</td><td>SUPPORTED (EMP upgrade)</td><td>SUPPORTED</td></tr>
<tr><td>Key Business Assumptions for WA</td><td colspan="4">There will be a local AEMO Control room in WA for system and market management.
Backup control room facilities will be negotiated with Western Power.
High systems availability is a requirement.
Western Power SCADA/EMS will remain in place to support the WA TNSP function.</td></tr>
<tr><td>Key System Interactions</td><td colspan="4">AEMO WA Control room operators require access to AEMO power system management platforms.
Western Power SCADA sends data to AEMO systems via redundant ICCP links.
AEMO EMS receives generation dispatch targets from WA real time market system.
SCADA data is made available to WA real time market system to assist with congestion management.</td></tr>
<tr><td rowspan="3">Functional alignment</td><td>Area</td><td>Risk</td><td>Impact</td><td>Primary Impact Area(s)</td></tr>
<tr><td>Initial</td><td>LOW</td><td>HIGH</td><td>COST</td></tr>
<tr><td>Potential to diverge</td><td>LOW</td><td>MEDIUM</td><td>TIME</td></tr>
<tr><td>Recommended architecture</td><td colspan="4"> 
</td></tr>
</table>

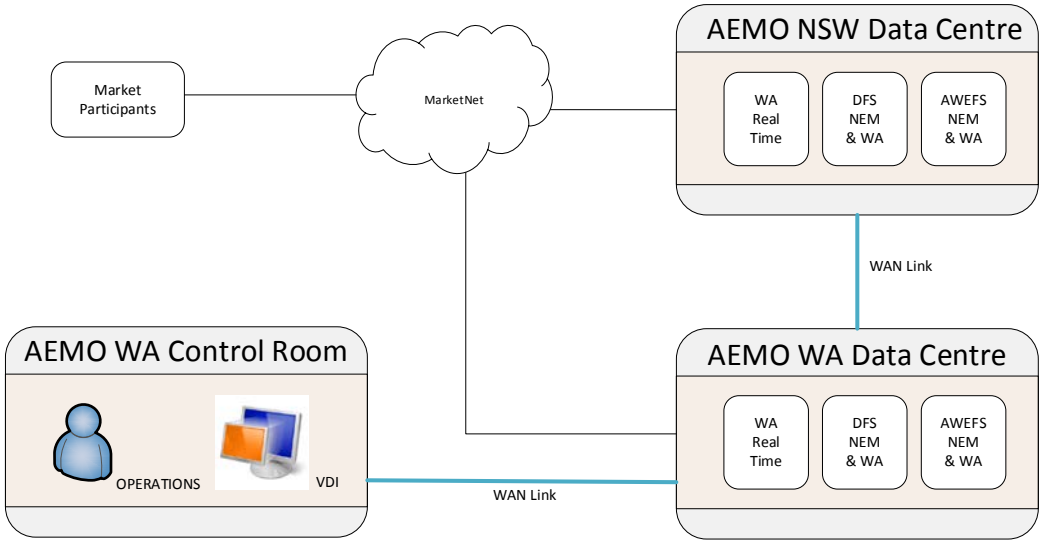
<table>
<tr><td>Rationale</td><td colspan="4">SCADA / EMS requirements are reasonably generic across different power systems.
Gas SCADA is run out of Victorian control room using VDI to the EMS platform in Norwest/NextDC hardware. This is a proven model for how WA could be implemented.
Maintaining Alstom platform ensures existing capabilities can be made available.
Network links for ICCP communications require only limited bandwidth.
Western Power will require connectivity onto MarketNet, so RTNet is a logical pipe on same connection.</td></tr>
<tr><td rowspan="3">Key Risks</td><td rowspan="2">Issue</td><td colspan="2">Project Impact</td><td rowspan="2">Lever</td></tr>
<tr><td>Small Large</td><td>Impact Type</td></tr>
<tr><td>EMP 3.x upgrade Stage 2 – Implementation completing Dec 2017 may impact WA implementation work. Needs more assessment.</td><td>  </td><td>  </td><td>Accelerate program of work to complete sooner.</td></tr>
<tr><td>WA power network has unique characteristics that requires software customisation.</td><td>  </td><td>  </td><td>An early survey of the power system elements in the WA network will resolve.</td></tr>
<tr><td>Questions</td><td colspan="4">Does AEMO phone systems need to connect to WA TNSP phones similar to NEM? --> Yes
Clarity around Western Power’s role.
Confirmation of how is black start handled.
Is there any merit in enabling an AGC control region for WA prior to security constrained dispatch being available?</td></tr>
</table>

B.2. Real Time Market

<table>
<tr><th colspan="5">Real Time Market</th></tr>
<tr><td>Functional overview</td><td>Mandatory</td><td colspan="3">• 5 minute dispatch
• Pre dispatch
• Bid and Offer
• Demand forecasting
• Wind, Base Solar and Rooftop PV generation forecasting
• Managing network constraints/congestion
• Energy/Ancillary Services Co-optimisation
• Reserve/Capacity assessment</td></tr>
<tr><td rowspan="2">Architectural Posture</td><td>System Status</td><td>System Complexity</td><td>Technology</td><td>Security</td></tr>
<tr><td>CORE</td><td>HIGH</td><td>END OF LIFE</td><td>SUPPORTED</td></tr>
<tr><td>Key Business Assumptions for WA</td><td colspan="4">• NEM frameworks and dispatch processes will be largely adopted as-is with potential for some opt-out on functionality.
• NEM security assessment tools can be applied to WA in existing form.
• Market participants will interact over MarketNet.
Batch interfaces will be aligned with NEM standards.
GUI interfaces will be made available to reduce technical barrier to entry.
• High systems availability is a requirement.
• Market will run in Western Standard Time.</td></tr>
<tr><td>Key System Interactions</td><td colspan="4">• Control room operators require access.
• Offline operations staff require access.
• Dependency on SCADA input – assume this is available from Power System Management platform.
• AWEFS system is shared across both markets and supplies forecasts into real time market system.
• Electricity DFS system is shared across both markets and supplies forecasts into real time market system.
• Generation targets are sent to Power System Management platform.
• Market Participants interact via MarketNet.
• Manual interface to Market Registration Systems for participant information.</td></tr>
</table>

Functional alignment	Timeframe	Risk	Impact	Primary Impact Area(s)
	Initial	MEDIUM	HIGH	FEASABILITY COST TIME
	Potential to diverge	MEDIUM	MEDIUM	COST

Recommended architecture



Rationale

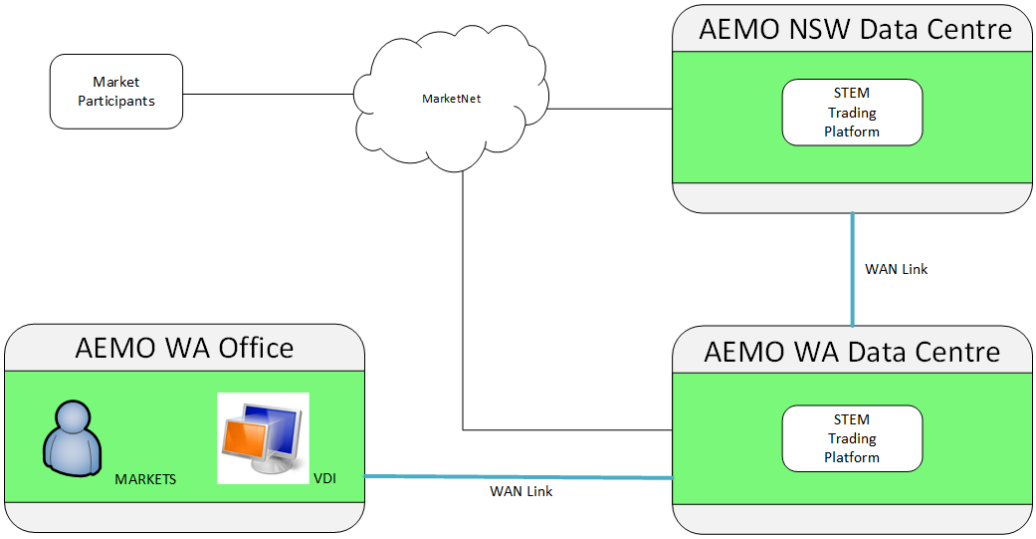
- Significant reduction in cost by removing the need for a WA data centre.
- Redundant WAN links to WA office can be procured using extension of existing Telstra/Optus networks such that remote access can be reliably serviced.
- Running WA market in a separate application instance reduces the risk of functional divergence and/or unintended impacts between NEM and WEM.
- Initial recommendation would be to maintain same application codebase and retain capability to clone source code to new application if divergent requirements emerge.

Key Risks

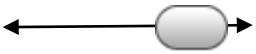
Issue	Project Impact (Small – Large)	Impact Type	Lever
Elements of underlying technology are at end of life. New deployments, particularly if source code is cloned and modified, may increase AEMO's overall technical debt.			As far as possible align to existing NEM business rules and avoid functional customisations.
Extent of work to suitable construct constraint equations to support security constrained dispatch.			As far as possible align to existing application functionality.
Extent of customisations required for WA is unknown.			As far as possible align to existing NEM business rules and avoid functional customisations that are not at the periphery of applications.
High requirement of SME resources in both business and IMT domains to implement.			The availability of SME with knowledge of NEM processes and systems is a key factor in successfully executing this initiative.

B.3. Day Ahead Market

Day Ahead Market

Functional overview	Mandatory	• Retain the existing STEM systems • Full integration into settlements to provide offsets against real-time market exposures • Contract position to be passed through as reallocations		
	Recommended	Upgrade to existing STEM software be completed prior to integration		
Architectural Posture	System Status	System Complexity	Technology	Security
	CORE	LOW	END OF LIFE	TBD
Key Business Assumptions for WA	• User access over MarketNet.			
Key System Interactions	• Market Participants enter bids and offers over MarketNet. • Trading platform sends cleared trades to Settlements.			
Functional alignment	Area	Risk	Impact	Primary Impact Area(s)
	Initial	LOW	LOW	COST
	Potential to diverge	LOW	LOW	COST
Recommended architecture				
Rationale	• STEM platform exists and requirements from reformed WEM are not expected to diverge from current market arrangements. • Number of trades and resulting data transfers means that comms links with latency will be acceptable to market participants.			

Key Risks	Issue	Project Impact	Impact Type	Lever
		Small Large		
	Current STEM implementation in end of life technology which is difficult to support. IP owned by ABB.			Need assessment of how STEM will be supported going forward.
	Integration to Market registration systems is unclear.			Need early assessment of requirements – STEM may not align with base registration platform.

	The STEM system has other dependencies, e.g. the Market Participant Interface (MPI). Participants should have single portal and data feeds across all market elements.			Need early investigation to confirm how the existing STEM can be uncoupled from other infrastructure/supporting systems.
	Ability to integrate STEM to prudential management platform.			Need early assessment of requirements?
Questions	• Is prudential assessment at time to trade execution a requirement?			

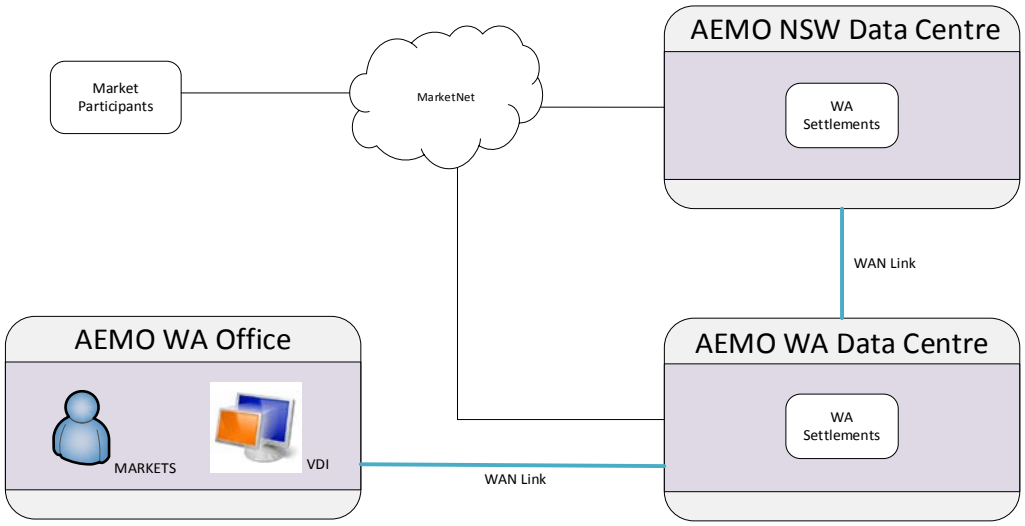
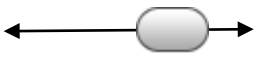
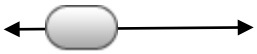
B.4. Reserve Capacity Mechanism

The requirements to support the Reserve Capacity Mechanism (RCM) require further consideration with transitional changes currently underway and an auction process to be implemented in the future. The RCM capacity certification and transitional price setting are undertaken in separate desktop systems and this is proposed to continue. These systems are currently being modified to meet immediate needs of the deferred 2015 cycle.

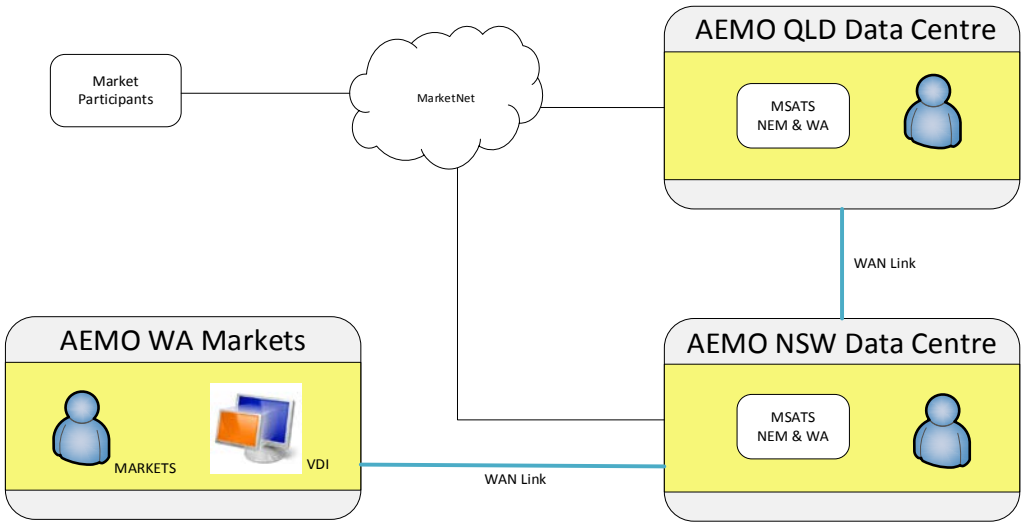
The systems proposal includes provisions for interfaces to input data into the settlements systems and to extract information from registration and market systems. This proposal is based on providing some basic elements which will need to be in place to capture and transactions within the RCM and between the RCM and other systems.

B.5. Settlements

<table>
<tr><th colspan="5">Settlements</th></tr>
<tr><td rowspan="3">Functional overview</td><td>Mandatory</td><td colspan="3">• Generation payments
• Retailer billing for customer energy
• On-Market ancillary service payment and recovery
• Off-Market ancillary service payment and recovery
• Financial instruments
• Billing & Invoicing
• Prudential management</td></tr>
<tr><td>Recommended</td><td colspan="3">• Reallocations</td></tr>
<tr><td>Optional</td><td colspan="3">• Early payments</td></tr>
<tr><td rowspan="2">Architectural Posture</td><td>System Status</td><td>System Complexity</td><td>Technology</td><td>Security</td></tr>
<tr><td>CORE</td><td>MEDIUM</td><td>END OF LIFE</td><td>MANAGED RISK</td></tr>
<tr><td>Key Business Assumptions for WA</td><td colspan="4">• WA Settlements adopts NEM-like practices for energy settlement functionalities.
• WA Settlements executes on a NEM-like settlement calendar.
• WA settlements are based around Western Standard Time boundaries.
• No offsetting mechanisms for prudentials between NEM and WEM.
• Real time, day ahead and reserve capacity mechanism will be settled on a common clearing platform.
• Real time, day ahead and reserve capacity mechanism prudentials will be assessed as a single position across the WEM market.
• Settlement recovery models will largely match those used in the NEM.
• Participants operating in both east and west coast electricity markets will receive separate invoices for credit/liabilities in each market.
• Market participants will interact over MarketNet.
Batch interfaces will be aligned with NEM standards.
GUI interfaces will be made available to reduce technical barrier to entry.
• Settlement function for WEM is run out of AEMO WA office.</td></tr>
<tr><td>Key System Interactions</td><td colspan="4">• Receives settlement data from FRC, Real Time, Day Ahead and RCM.
• Settlement staff managing settlement, billing and prudential processes require access.
• Market Participants interact via MarketNet.
• Manual interface to Market Registration Systems for participant information.</td></tr>
<tr><td rowspan="3">Functional alignment</td><td>Area</td><td>Risk</td><td>Impact</td><td>Primary Impact Area(s)</td></tr>
<tr><td>Initial</td><td>LOW</td><td>MEDIUM</td><td>COST
TIME</td></tr>
<tr><td>Potential to diverge</td><td>MEDIUM</td><td>MEDIUM</td><td>COST</td></tr>
</table>

<table>
<tr><td>Recommended architecture</td><td colspan="4"> 
</td></tr>
<tr><td>Rationale</td><td colspan="4">Clone of NEM Settlement systems into separate application instances servicing WA only is necessary to ensure WA market can be independently managed.
Prudentials for WA will need to be managed separately to other markets, so best to separate system.
Settlements does not have a high availability requirement, so the risk of a disconnection of a WAN link between WA and east coast data centres is not significant.</td></tr>
<tr><td rowspan="4">Key Risks</td><td rowspan="2">Issue</td><td colspan="2">Project Impact</td><td rowspan="2">Lever</td></tr>
<tr><td>Small Large</td><td>Impact Type</td></tr>
<tr><td>Settlement systems across a number of areas require renovation. Deploying these solutions to a new area increases the size of this issue.</td><td>  </td><td>  </td><td>Keeping requirements as consistent with NEM as reasonably possible will help to ensure that a future renovation program can meet the WEM and NEM functional requirements.</td></tr>
<tr><td>Derogations may result in a need for new specific settlement exceptions to be implemented in the WA settlement system.</td><td>  </td><td>  </td><td>Limiting exceptions where possible is desirable to avoid introducing requirements for software customisation.</td></tr>
<tr><td>High requirement of SME resources in both business and IMT domains to implement.</td><td>  </td><td>  </td><td>The availability of SME with knowledge of NEM processes and systems is a key factor in successfully executing this initiative.</td></tr>
</table>

B.6. Retail Market

<table>
<tr><th colspan="5">Retail Market</th></tr>
<tr><td>Functional overview</td><td>Mandatory</td><td colspan="3">Central repository for standing data
Customer transfer facilitation
Objection management
Meter data management
Profiling for accumulation meters
Energy settlement</td></tr>
<tr><td rowspan="2">Architectural Posture</td><td>System Status</td><td>System Complexity</td><td>Technology</td><td>Security</td></tr>
<tr><td>CORE</td><td>LOW</td><td>END OF LIFE</td><td>MANAGED RISK</td></tr>
<tr><td>Key Business Assumptions for WA</td><td colspan="4">WP to continue to be the Metering Data Provider for meters it currently reads.
Meter reads interpreted as Western Standard Time.
MSATS update time stamps remain as Eastern Standard Time.
Overnight MSATS Credit Request processing will remain a single run for both WA and NEM NMIs.
There will be WA Jurisdictional differences (NMID, CRs, OBJs etc.).
WA will have different Settlement Time frames (0800 to 0800 Thursday to Thursday).
External interfaces for market participants to interact with WA FRC must be consistent with the existing for the east coast FRC market.</td></tr>
<tr><td>Key System Interactions</td><td colspan="4">Sends energy settlement data to settlements system.
Market Participants interact via MarketNet.
Meter Data Providers submit metering data via MarketNet.
Manual interface to Market Registration Systems for participant information.</td></tr>
<tr><td rowspan="3">Functional alignment</td><td>Area</td><td>Risk</td><td>Impact</td><td>Primary Impact Area(s)</td></tr>
<tr><td>Initial</td><td>LOW</td><td>LOW</td><td>COST</td></tr>
<tr><td>Potential to diverge</td><td>LOW</td><td>LOW</td><td>COST</td></tr>
<tr><td>Recommended architecture</td><td colspan="4">Shared
Wholesale POMAX functions will be replaced by an expansion of existing WA wholesale and EMMS functions
Retail POMAX functions (storage of meter reads) will be replaced by MSATS functions 
</td></tr>
<tr><td>Rationale</td><td colspan="4">Existing customer transfer system already designed to handle multiple jurisdictions. Configuration for WA should be relatively straight forward.
Existing electricity retailers are already integrated into MSATS.
Not a time critical system and no strong requirement for highly available local access from AEMO WA office.</td></tr>
</table>

Key Risks	Issue	Project Impact Small Large	Impact Type	Lever
	Interactions with Power of Choice (PoC) program of work.			Potential for conflict between Power of Choice and early market trials in WEM FRC.
	The MSATS systems has been identified as on end of life technology.			Keeping requirements as consistent with NEM as reasonably possible will help to ensure that a future renovation program can meet the WEM functional requirements.
	High requirement of SME resources in both business and IMT domains to implement.			The availability of SME with knowledge of NEM processes and systems is a key factor in successfully executing this initiative.
	Disparate protocols in use between east and west coast FRC markets.			An agreement to not provide support for the WA variant of aseXML will simplify market systems. The impacts on existing WA participants will need to be assessed.
Questions	• Run in parallel for a period prior to July 2018.			