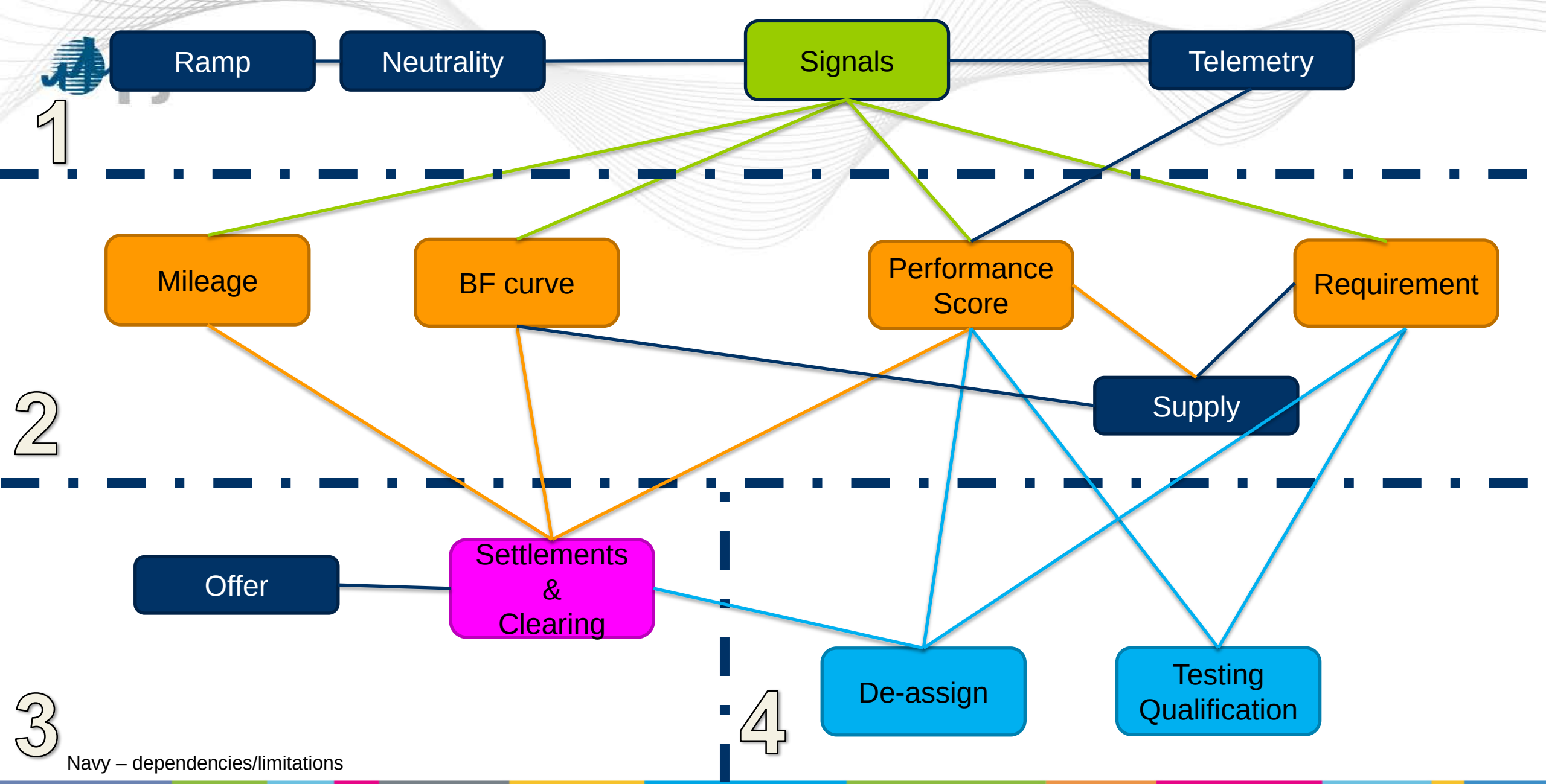
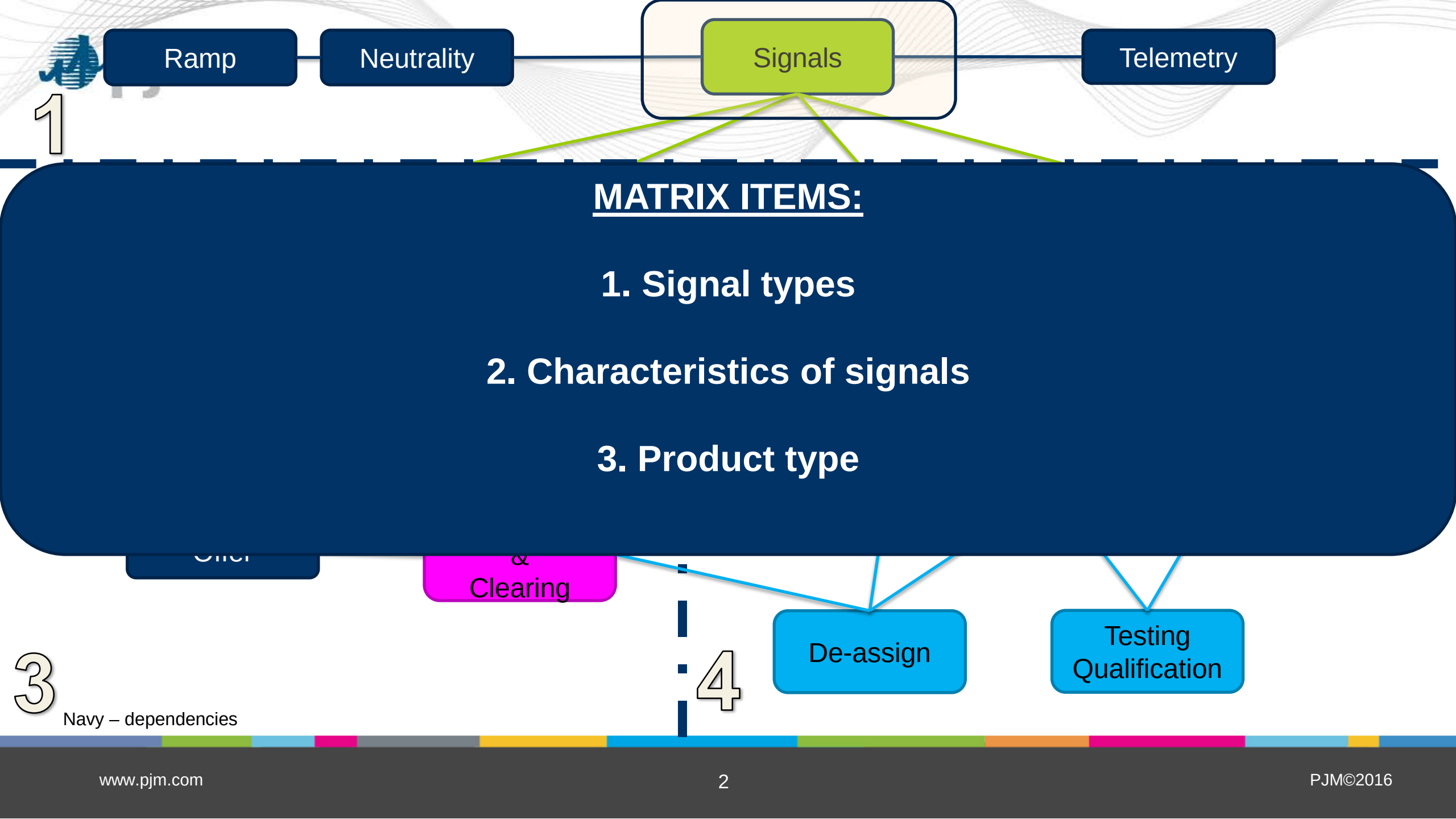


Navy – dependencies/limitations


Ramp
Neutrality
Signals
Telemetry
1
MATRIX ITEMS:
1. Signal types
2. Characteristics of signals
3. Product type
Clearing
De-assign
Testing
Qualification
3
4
Navy – dependencies

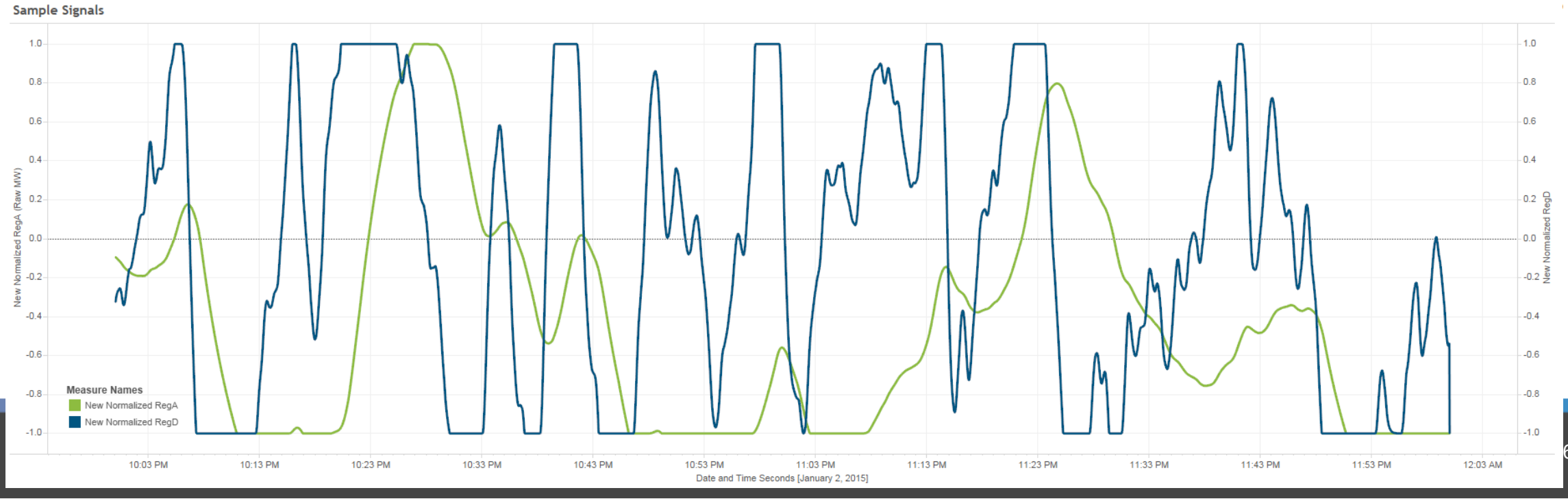
Signals

1. **Signal types –** (Status Quo) 2- Reg A & Reg D
   - Having both Reg A and Reg D provides value to the system, allowing for energy limited and ramp limited resources to provide the most value to the regulation service.

3. **Product type –** (Status Quo) Combined/bi-directional, symmetric
   - Current combined/bi-directional, symmetric signals market has a large capacity available. PJM sees no constraints on this signal design in the market and sees the most value with this design operationally.

2. Characteristics of signals- (Option L) Conditional neutrality over 30 minutes (will be evaluated and potentially modified/phased out over X months.)

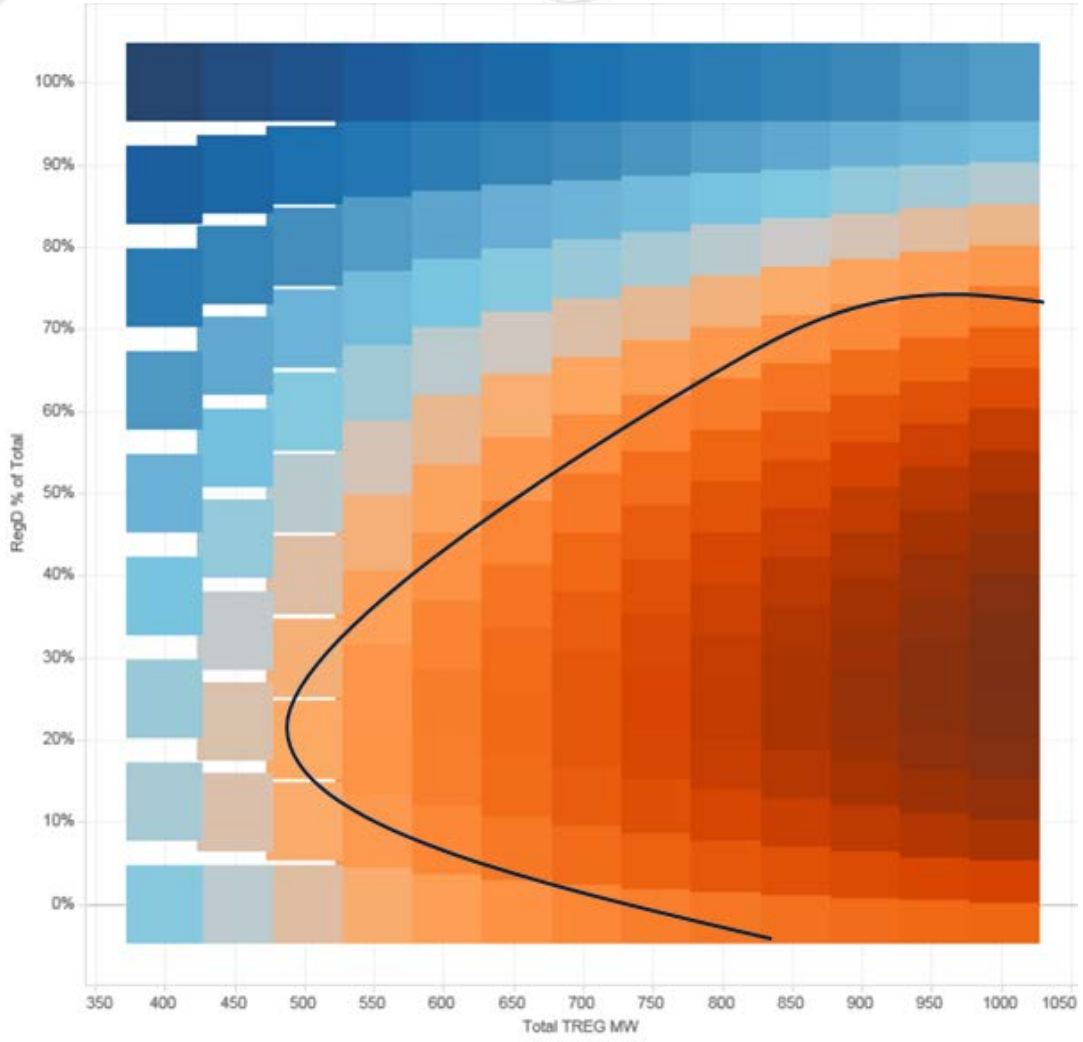
- The signal will try to respect the energy limitation of Reg D resources by modeling a general 30-minute state of charge. However, when required, the Reg D signal will still dispatch resources outside of their anticipated energy capabilities. Example signal below:

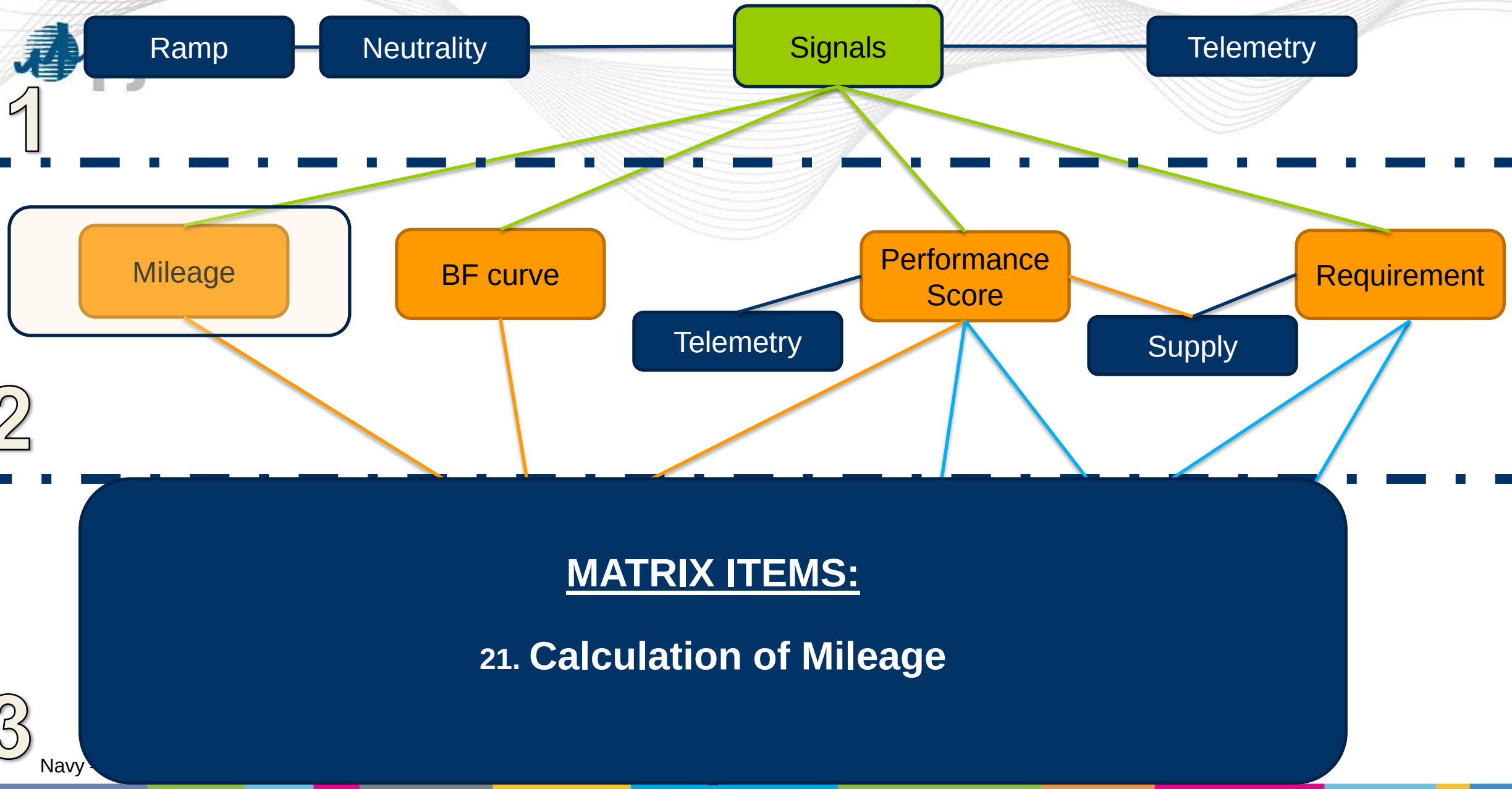


Isoquant Map - Definition of Signals

- Isoquants are evaluated by season and by “ramping/non-ramping” hours to determine the control metrics for Reg A/Reg D combinations.

- An example isoquant is shown for demonstration purposes, and is evaluated with a defined control value.



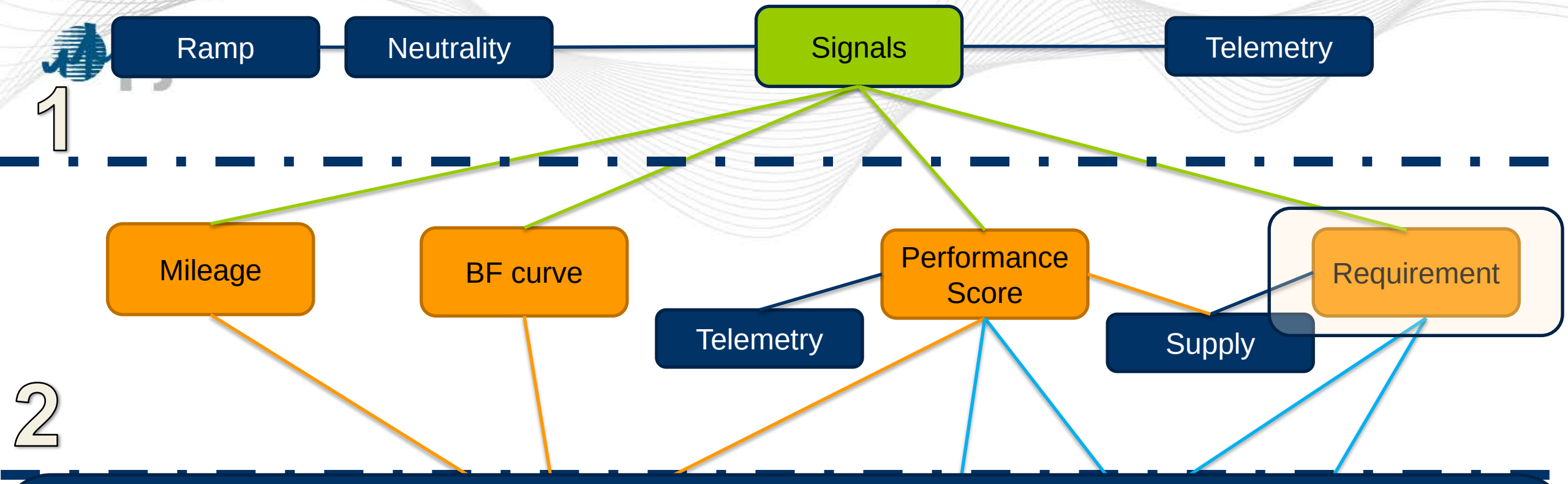

Ramp
Neutrality
Signals
Telemetry
1
Mileage
BF curve
Performance Score
Requirement
Telemetry
Supply
2
MATRIX ITEMS:
21. Calculation of Mileage
3

21. Calculation of Mileage – (Status Quo) All movement regardless of direction

- Mileage will be calculated as the absolute movement of the regulation control signal, as it is today. The Reg A and Reg D signal redesign with dependent signals is designed for all movement to be beneficial to the system.

Use of mileage

- Mileage will be used in the performance offer for regulation resources ($/mile). Proposal for the mileage multiplier to be removed from the settlements.



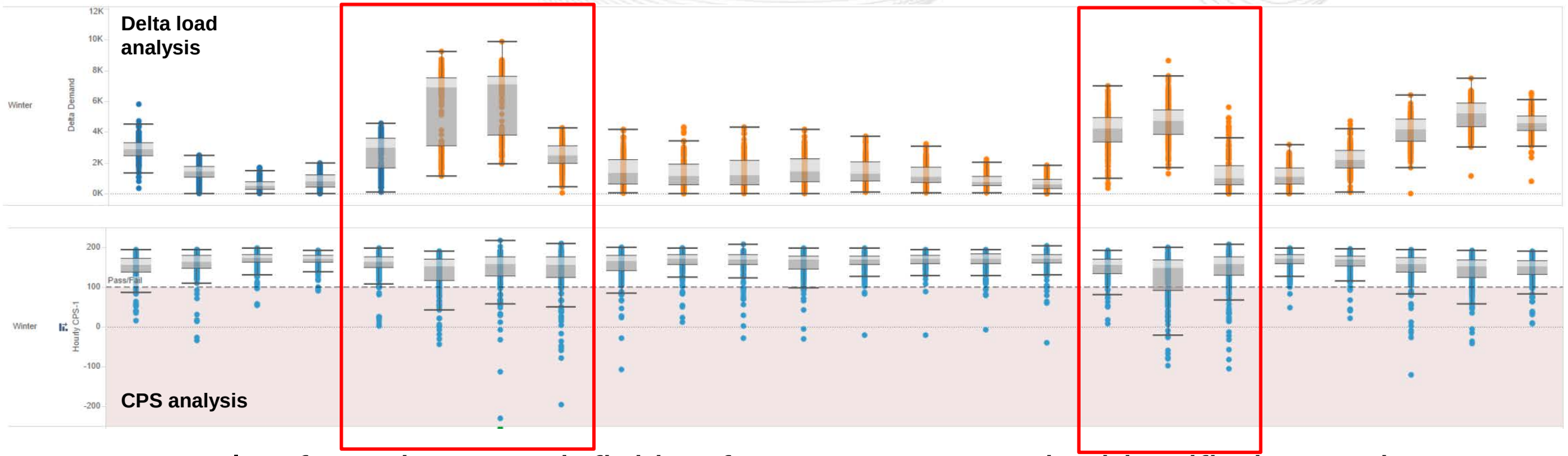
MATRIX ITEMS:

4. Requirement Level
5. Static or dynamic

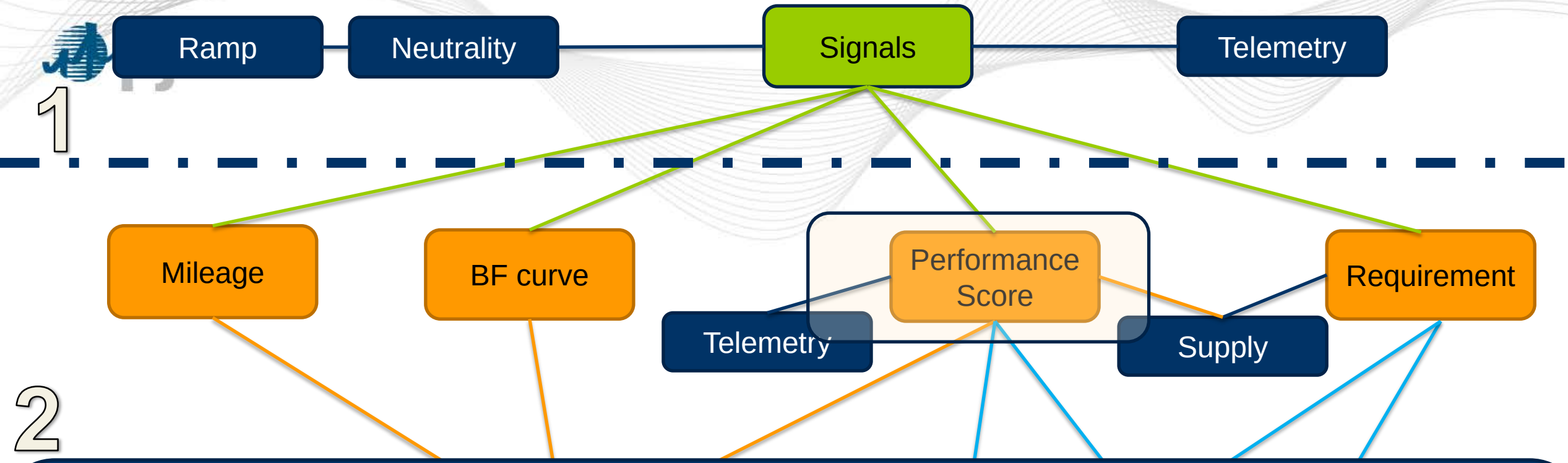
4. **Requirement Level** / 5. **Static or dynamic –** (Option B -Modified) Static- Different requirement for identified “ramping” periods (C) Seasonally and/or Hourly

- Proposing to have different requirements seasonally and for “ramping” and “non-ramping” periods. The “ramping” and “non-ramping” periods are defined by a historical CPS score analysis and delta load analysis. (MRTS will be evaluated based on different requirements.)

Requirement



- Example of requirement definition for one season. The identified “ramping” hours (red boxes) will have a higher requirement than the identified “non-ramping” hours. The ramping hours are defined from historical analysis, and selected when we have either lower CPS scores, higher delta loads, or a measureable amount of variability of CPS scores and/or delta load.



MATRIX ITEMS:

16. Components of performance scoring and weight
18b. Minimum allowable settlement threshold
18. Minimum allowable price-setting threshold
17. Minimum allowable participation threshold

16. Components of performance scoring and weight- (Status Quo) Units measured on a composite performance score = 1/3 accuracy + 1/3 delay + 1/3 precision

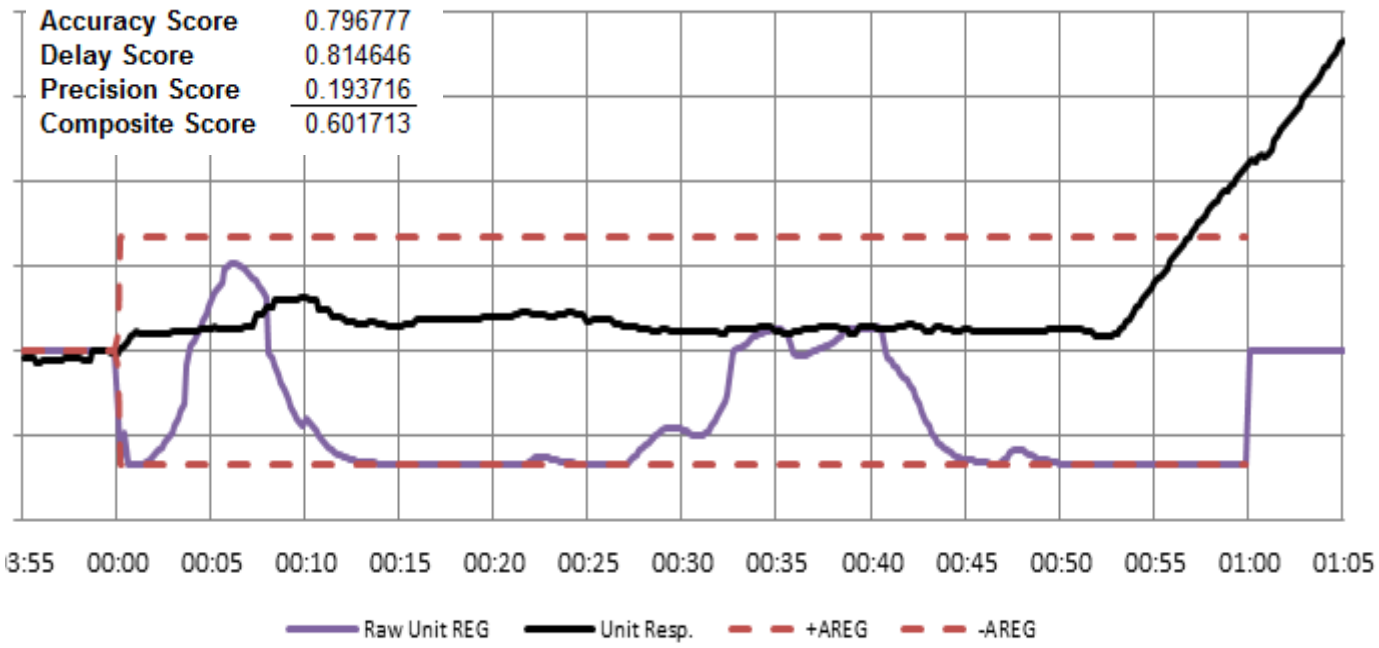
18. Minimum allowable price-setting threshold- (Status Quo) None

- All pool scheduled resources providing regulation can set price.

18b. Minimum allowable settlement threshold: (Option A) 25% minimum threshold for each component for the hour

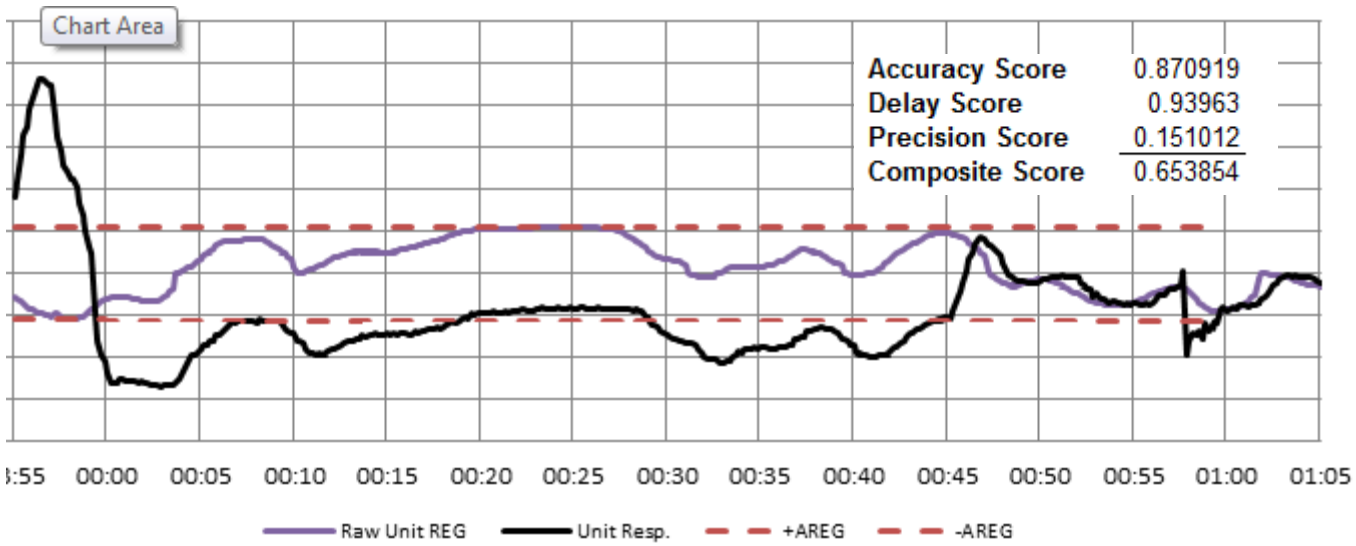
- Regulation compensation is currently when a resource's composite score is 25% or greater in current hour. Proposing to compensate resource when each component (accuracy, delay, precision) score is greater than 25% in current hour.

18b. Minimum allowable settlement threshold: 25% minimum threshold for each component for the hour



- Precision Score below 25% - no compensation for the hour. Resource was not following regulation signal.
- Resource has high historic performance score; do not want resource to not participate going forward but should not be compensated for the hours where they did not provide acceptable service.

18b. Minimum allowable settlement threshold: 25% minimum threshold for each component for the hour

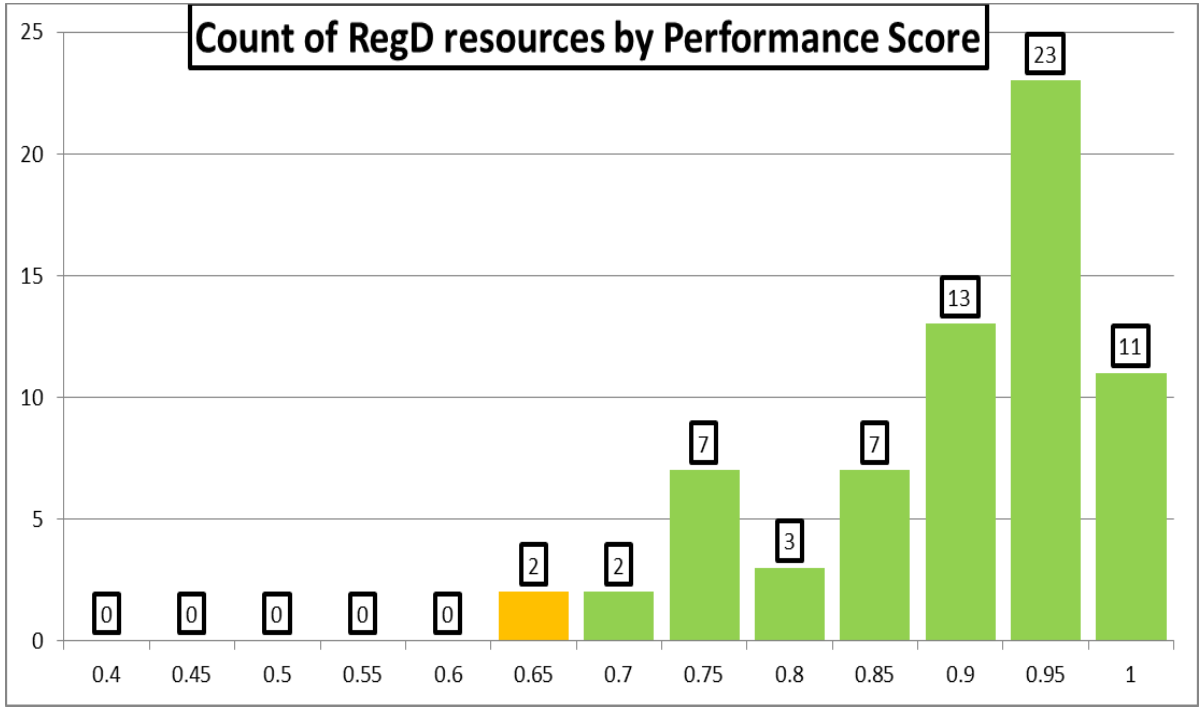


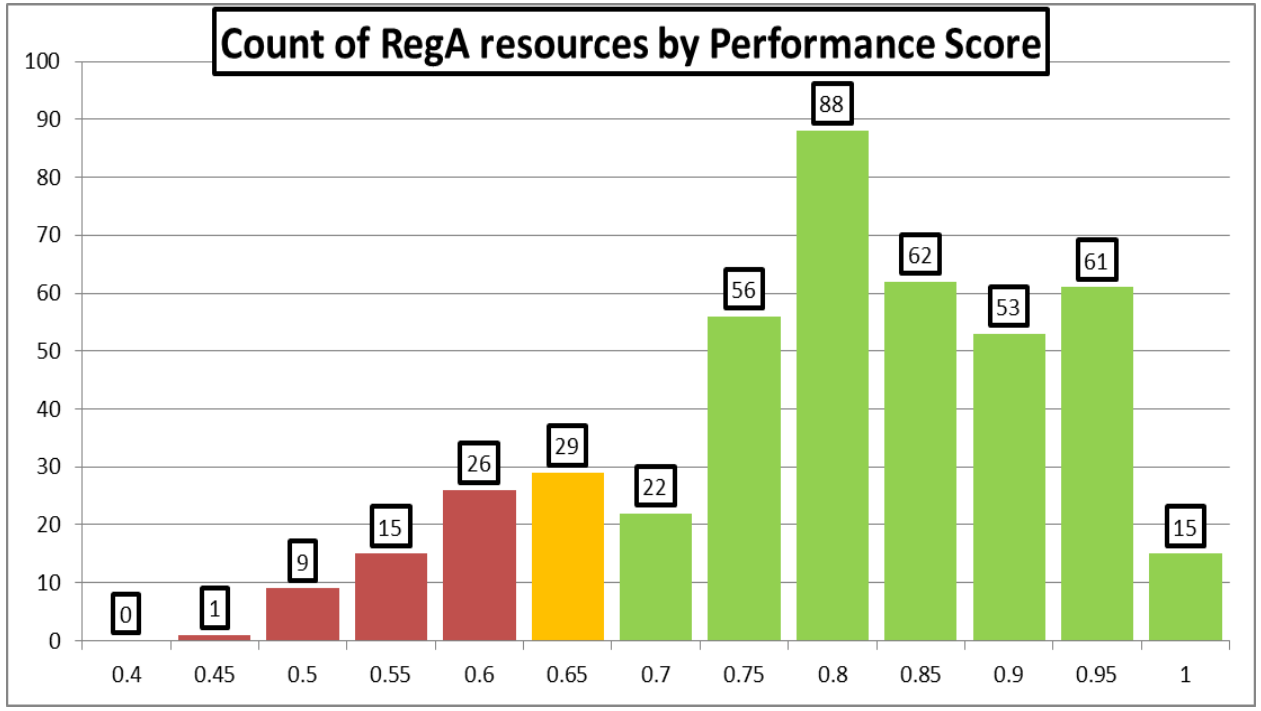
- Precision Score below 25% - no compensation for the hour
- Resource was off its basepoint for the regulation hour. Even though the shape of the response is in line with the regulation signal, this resource could be negatively impacting the system.

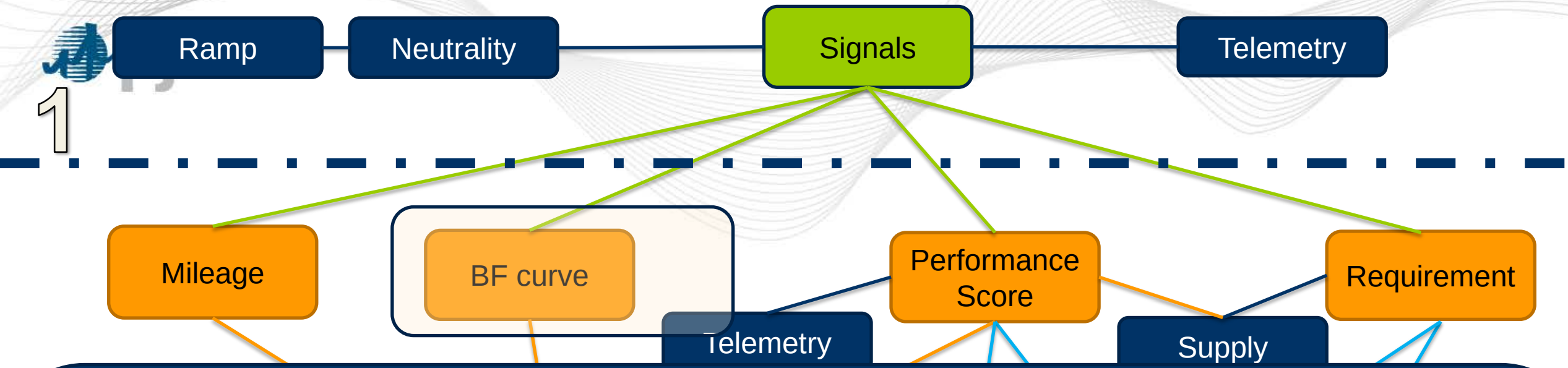
17. Minimum allowable participation threshold- (Option B- Modified) Lower than qualification score but higher than current 40%

- Proposal to raise the minimum participation threshold to 60%. This will allow only consistently quality performing resources in the market.

- Evaluation of resource impact to increased participation threshold:







MATRIX ITEMS:

6. Operational characteristics considered
7. X axis
8. Y axis
9. Static or dynamic
10. Effective MW calculation
11. Procurement floor- (C) Floor at BF=0
12. Treatment of Self Schedule and $0 offers

6. Operational characteristics considered – (Option A) Sustain output, ramp limitation, sunset neutrality

- Operation characteristics to define the MRTS will be derived from the operation study and isoquant curves. The control metric used to define the isoquant curves will take into account sustain output, ramp limitations and neutrality (currently using 30 minute conditional neutrality).

7. X axis – (Option E) Reg D megawatts (Performance Adjusted)

8. Y axis- (Option E) Marginal Rate of Technical Substitution reflects engineering assumptions about the rate of substitution between Reg D and Reg A; will change as we sunset neutrality (TBD)

- MRTS - rate of substitution (in performance adjusted MW) between Reg D performance adjusted MW and Reg A performance adjusted MW based on engineering analysis. In other words, the marginal amount of performance adjusted Reg A displaced by the next performance adjusted MW of Reg D.

9. Static or dynamic – (Option A) Static for predefined periods of time, based on the regulation requirement and engineering relationship

- The MRTS will be evaluated and defined in line with the requirement definition and control metric studies (seasonal, “ramping/non-ramping” hours).

10. Effective MW calculation- (Option A) Area under the curve

- The clearing engine maintains proportions as defined by the MRTS; effective MW calculation allows procurement of one of the defined Reg A-Reg D “MW pairs”.

11. Procurement floor- (Option C- Modified) Floor at MRTS=0

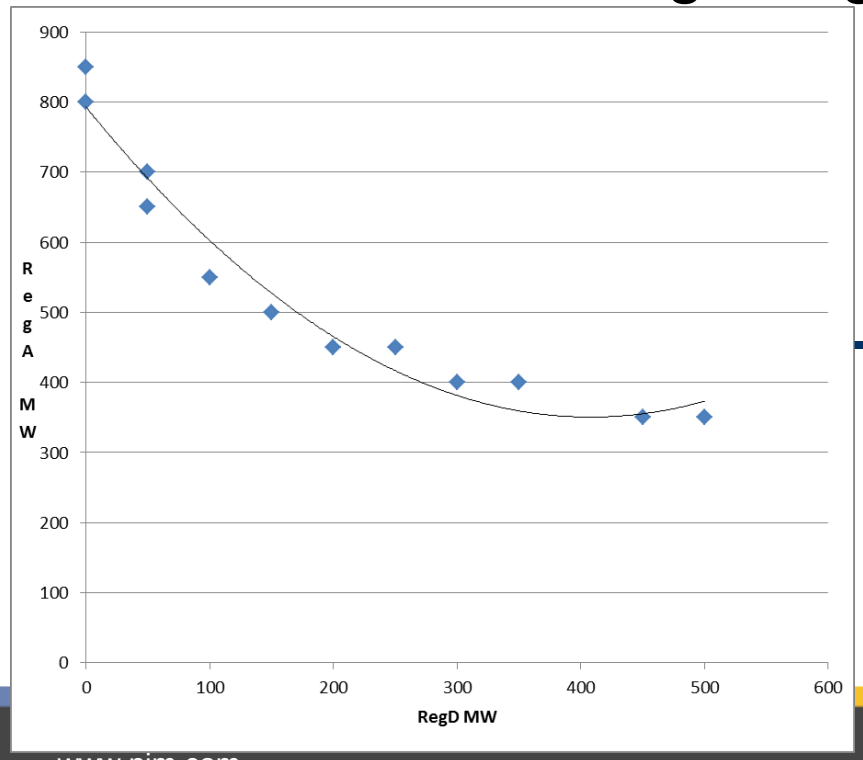
- Regulation will be procured economic up to MRTS=0.

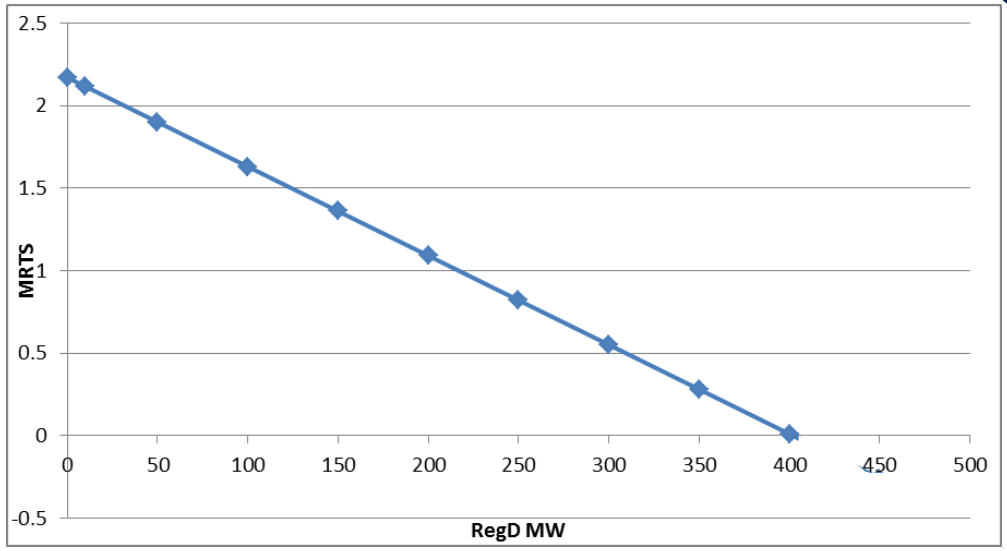
12. Treatment of Self Schedule and $0 offers- (Status Quo) Self schedule and $0 offer will be subject to a tie breaker based on performance score.

- Updates implemented with RPI changes to remove the block clearing and MRTS of $0 offer and self schedule resources.

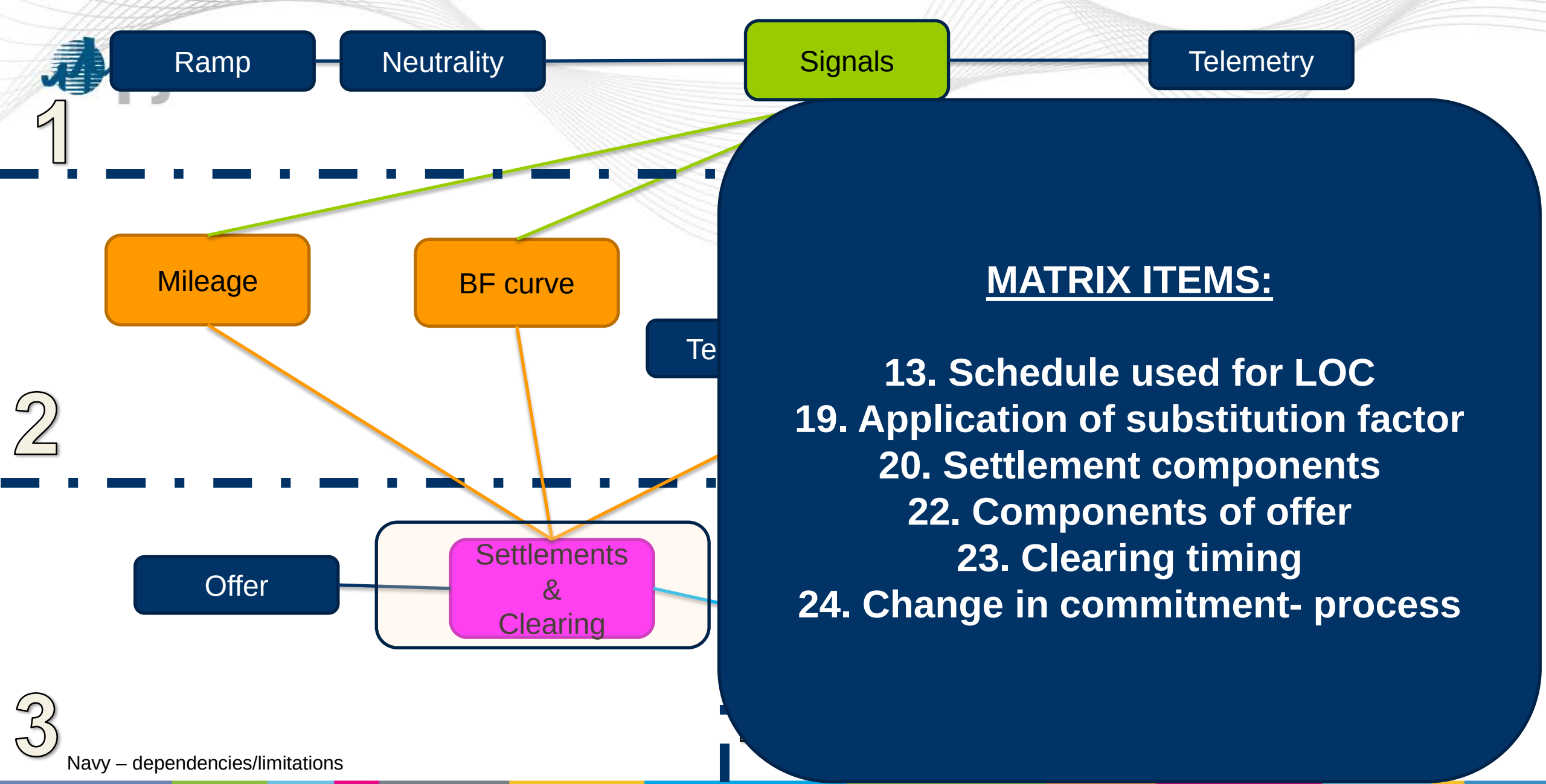
Defining the MRTS

- See presentation by IMM for full details.
  - "Reg A/Reg D MW pairs" will be defined based on study simulation isoquants and the MW pairs will be translated into a MRTS curve for regulation clearing.
  - MRTS does not go negative.



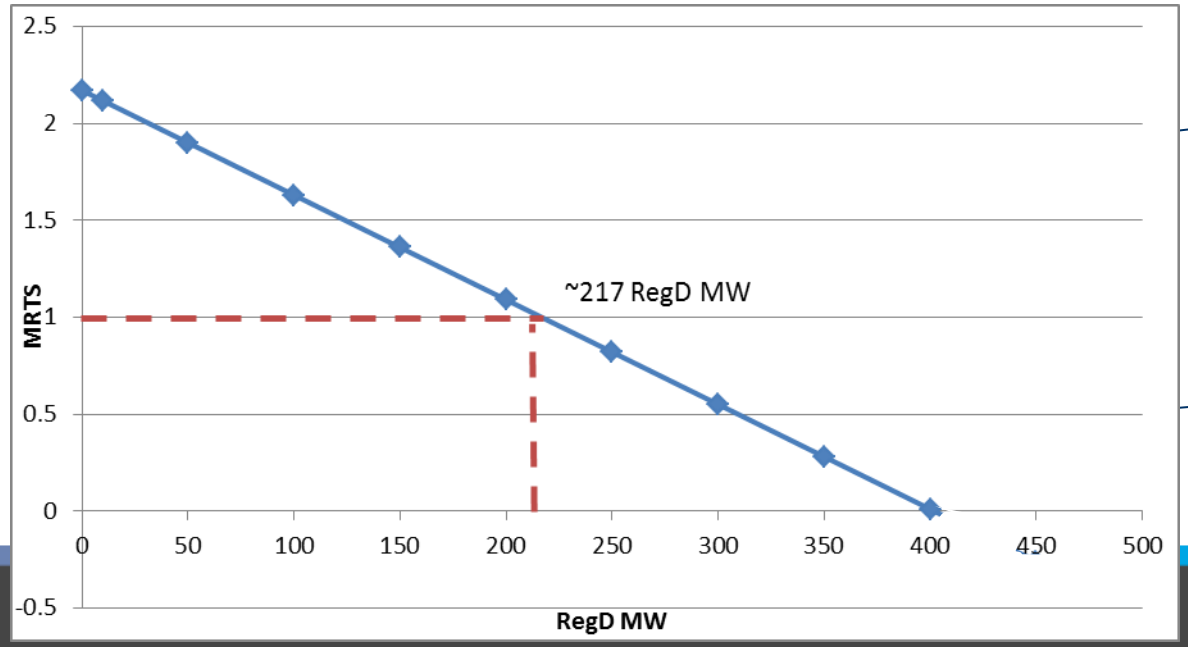


MRTS curve


Ramp
Neutrality
Signals
Telemetry
1
Mileage
BF curve
Te
2
Offer
Settlements
&
Clearing
3
Navy – dependencies/limitations
MATRIX ITEMS:
13. Schedule used for LOC
19. Application of substitution factor
20. Settlement components
22. Components of offer
23. Clearing timing
24. Change in commitment- process

19. Application of substitution factor – (Option A) Replace Mileage Ratio from the Performance Credit with Marginal Rate of Technical Substitution. Add MRTS to the Capability Credit.(Settled at Effective MW)

- New Equation = MW*PS*MRTS*CCP + MW*PS*MRTS*PCP
- MRTS for REGA Resources = 1; MRTS for Reg D resources will be defined by MRTS curve and cleared Reg D.



If Marginal Reg D resource clears in this space, all Reg D settlements will use an MRTS > 1.

If Marginal Reg D resource clears in this space, all Reg D settlements will use an MRTS < 1.

13. Schedule used for LOC- (Option A) Use the schedule the resource was committed on

20. Settlement components – (Status Quo) 5 minute pricing, hourly settlements

22. Components of offer- (Status Quo)- Performance and Capability

- Need both performance and capability offer to capture the pay for performance (mileage) offer.

23. Clearing timing- (Status Quo)- 30 minutes before, one hour commitments

24. Change in commitment- process- (Status Quo)- None

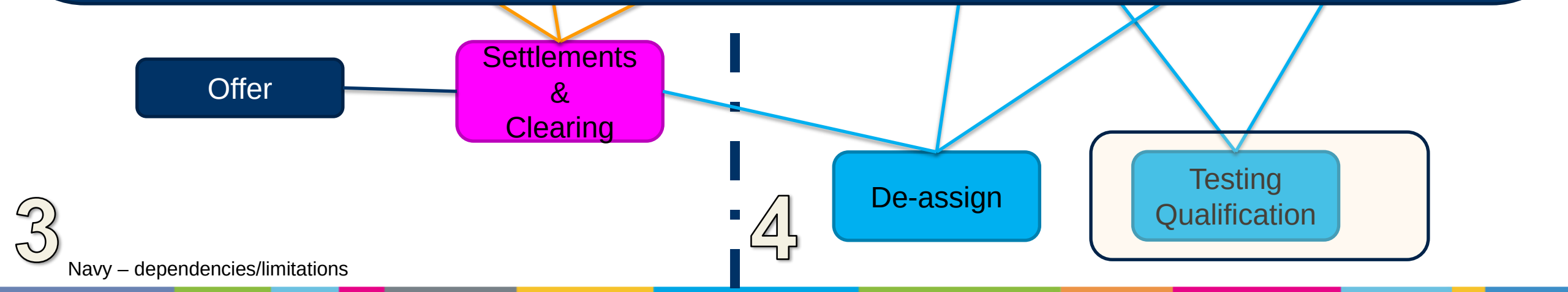
- Commitment process should stay the same.

MATRIX ITEMS:

14. Qualification testing

26. Qualification Testing Transition Plan

15. Type specific testing/scoring



14. Qualification Testing- (Option A- Modified) Increase the minimum testing score from 75% to a 80%

- Recommending the score increase to 80% for qualification and uprate tests. Increasing the minimum test score to ensure resources perform satisfactorily in all three components of the performance score.

14. Qualification Testing- (Option C) Minimum uprate increments and/or periodicity for uprate tests

- Uprate tests will be limited to once a quarter.

(Option F- Modified) Signal change tests- Meet or exceed the participation threshold score (60%) on 1 test

- The purpose of the signal re-test is to ensure all communication is still operating properly, not necessarily unit performance. PJM does not want to discourage system upgrades because of regulation tests.

26. Qualification Testing Transition Plan- (New) New test signals will be designed to test resources on the new signals. Any trigger for a re-test (signal change, uprate, disqualification) will require resources to test against new signals; new resources will need to test against new signals.

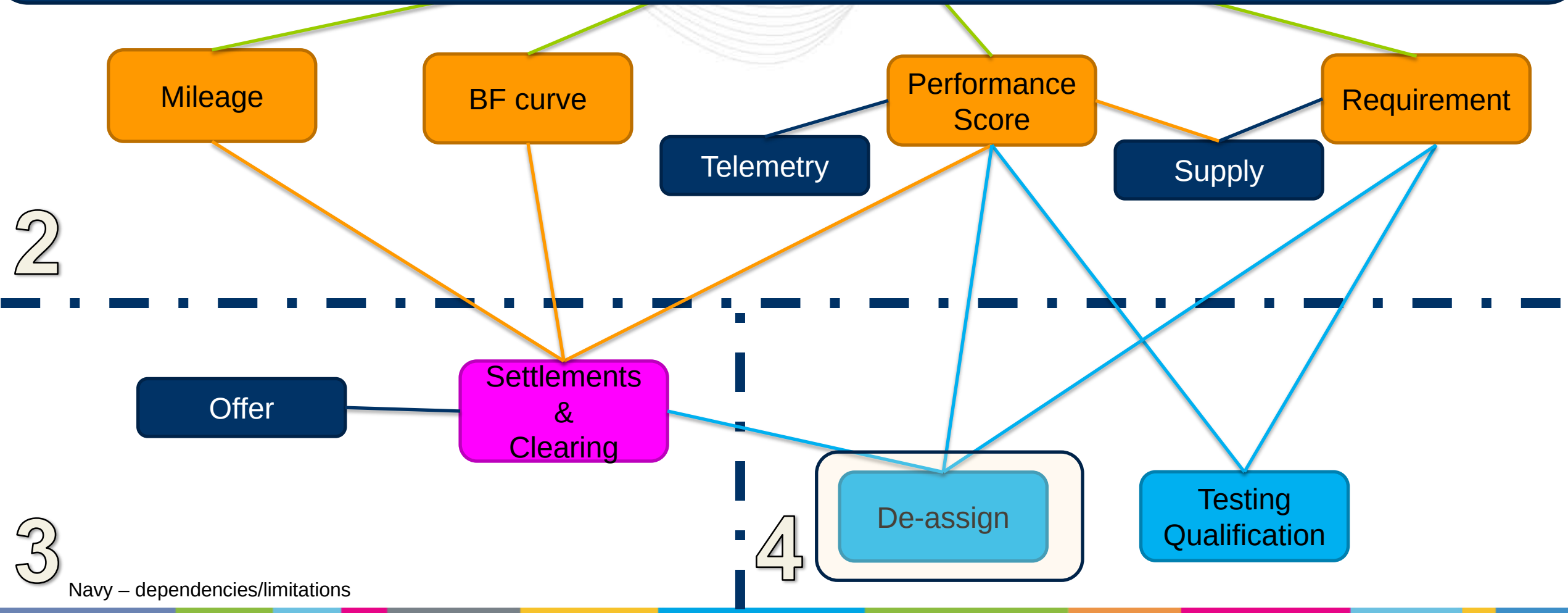
- Resources will need to test against new test signals designed for the new operational signals.

15. Type specific testing/scoring – (Status Quo) None (A&D testing requirements/thresholds are the same)

- All resources should be treated equally.

MATRIX ITEM:

18A. Change in cleared commitment - performance score

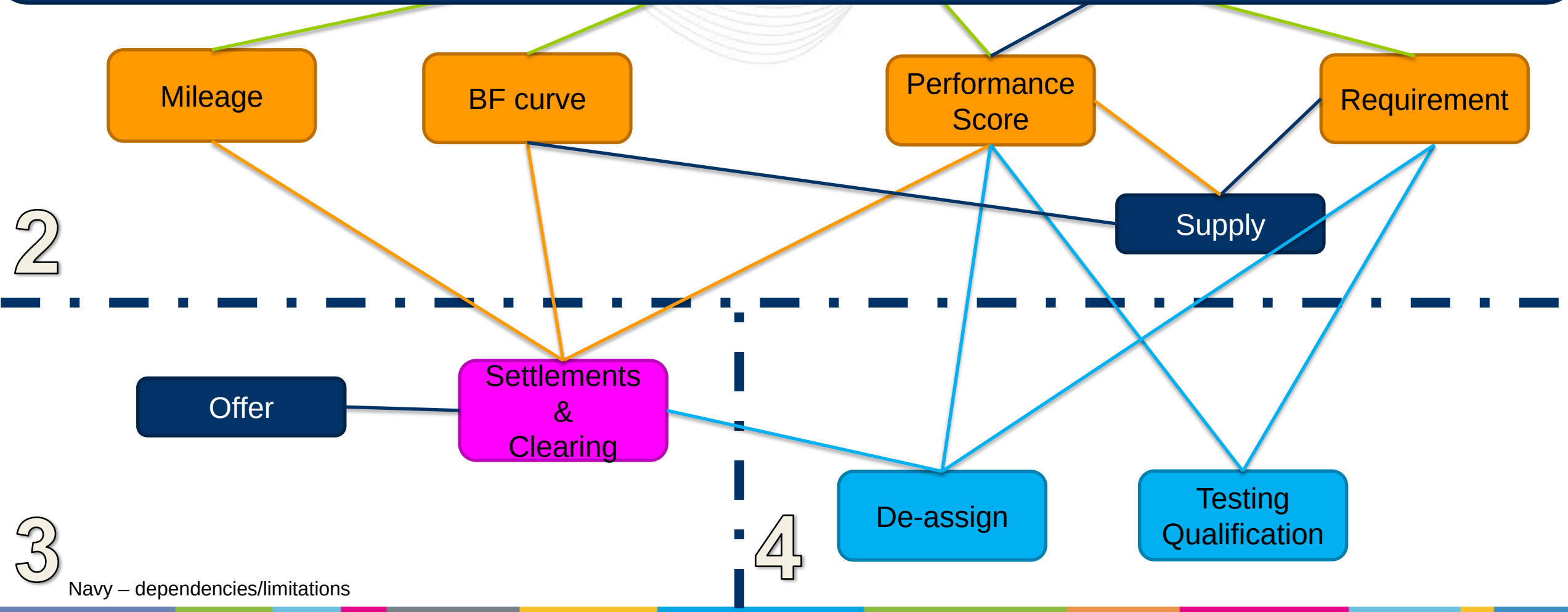


18A. Change in cleared commitment- performance score- (Option C) Self de-selection impacts performance

- Self de-selection results in zero score for remainder of hour.
- PJM dispatch de-selection will not impact performance score.

MATRIX ITEM:

Implementation and Transition Plan



Implementation & Transition

- Implementation and Transition Plan
  - Testing Window – with new controller (TBD)
  - Implement signal and market changes concurrently