WESTERN POWER DISTRIBUTION

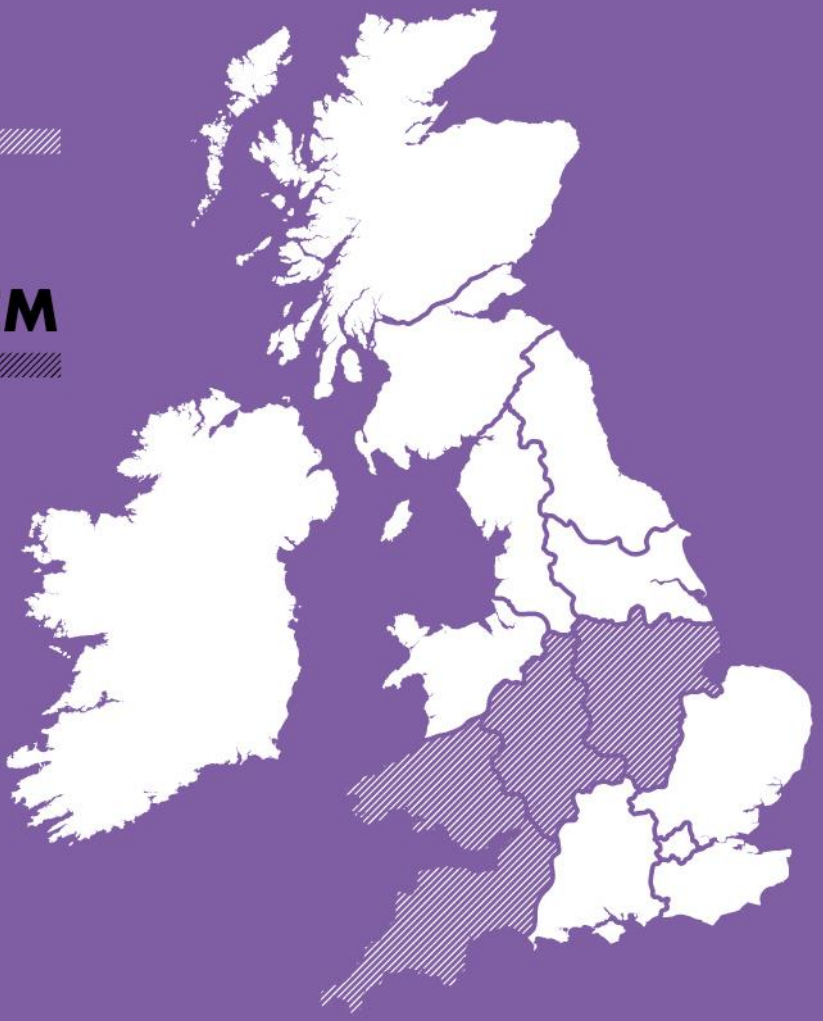
EFFS

ELECTRICITY FLEXIBILITY AND FORECASTING SYSTEM

EFFS

WPD_EN_NIC_003

NIC PROJECT
System Design:
Scheduling



RIIO NIC NETWORK INNOVATION COMPETITION

Report Title	:	System Design: Scheduling
Report Status	:	FINAL REDACTED
Project Reference:	:	WPD/EN/NIC/03
Date	:	25/10/2019

Document Control		
	Name	Date
Prepared by:	Michael Pearson	09/09/2019
Reviewed by:	Jennifer Woodruff	09/09/2019
Approved by:	Ben Godfrey	14/10/2019
	Paul Hartshorne	15/10/2019
	Jonathan Berry	16/10/2019
	Sarah Hadfield	22/10/2019

Revision History		
Date	Issue	Status
18/07/2019	0.1	TEMPLATE
20/08/2019	0.2	DRAFT
23/08/2019	0.3	DRAFT
18/09/2019	0.4	DRAFT
02/10/2019	0.5	DRAFT
08/10/2019	0.6	DRAFT
09/10/2019	0.7	DRAFT
09/10/2019	0.8	ISSUED FOR APPROVAL
16/10/2019	1.0	FINAL
25/10/2019	2.0	FINAL REDACTED

Contents

DISCLAIMER

Neither WPD, nor any person acting on its behalf, makes any warranty, express or implied, with respect to the use of any information, method or process disclosed in this document or that such use may not infringe the rights of any third party or assumes any liabilities with respect to the use of, or for damage resulting in any way from the use of, any information, apparatus, method or process disclosed in the document.

Telephone +44 (0) 1332 827446. E-mail wpdinnovation@westernpower.co.uk

1 Purpose of this document

The purpose of this document is to specify how the scheduling requirements defined in the EFFS project's DSO Requirements Specification will be delivered from a functional perspective. The document forms one of eight system design documents (listed below), namely the scheduling design document. The system design documents complement the System Design Summary Report, which contains an overview each functional area and the relationships between them.

- Forecasting;
- Capacity Engine;
- Service Management;
- Optimisation;
- **Scheduling;**
- Conflict avoidance and synergy identification;
- Market Interface; and
- Reporting.

In accordance with the EFFS Project Direction, this document forms part fulfilment of the project's fourth deliverable to Ofgem, the 'EFFS system design specification'.

2 Executive summary

The scheduling function of EFFS takes the output of the optimisation function (the proposed chosen services and associated delivery profiles that best satisfy the forecasted network requirements as per the specified optimisation parameters) for user validation and converts this into a confirmed service schedule ready to be issued to the relevant Flexibility Platforms. The key decision in this area during the project's WS1 was whether a user would want to be able to view and dispatch flexibility within EFFS or within the existing WPD control room system (PowerOn[1]). The latter was the consensus position reached in the associated project workshop. This was based on the thinking that it would be inefficient for the control room users (who would be dispatching the post-fault services in near real time and then monitoring the network) to use two systems rather than PowerOn only. During the design phase this approach has been ratified with the relevant subject matter experts and an approach for achieving this technically defined. The approach we have adopted attempts to minimise change to PowerOn both to reduce cost, negative system performance impact and also to avoid disruption to existing user experience.

[1] https://www.gegridsolutions.com/products/brochures/uos/PowerOn_Control.pdf

3 Glossary

Term	Definition
API	Application Programming Interface
Constraint	For the purpose of EFFS, this refers to thermal network constraint, as opposed to voltage constraints.
CLEM	Cornwall Local Energy Market
DSO	Distribution System Operator
EFFS	Electricity Flexibility and Forecasting Systems
Fxibility platform	See Appendix 1: Flexibility platform for details
HH	Half Hourly electricity metering
HV	High voltage
Affinity Networkflow or Networkflow	Proprietary software suite developed, licenced and maintained by AMT-SYBEX relating to the management of flexibility services for electricity networks.
PowerOn	WPD's Distribution Management System provided by General Electric
Service type	Types of peak shaving flexibility services that will be supported by EFFS (namely scheduled constraint management, pre-fault constraint management, post-fault constraint management, restoration support)
User	Users of the EFFS system are anticipated to be: • **Forecaster and flexibility co-ordinator** up until the real time management, dispatch and monitoring. Note: both these roles do not currently exist but are required, as they do not map onto an existing business function. The flexibility co-ordinator role will have a very similar skill set to that of an outage planner, whereas the forecaster role will require individuals with a mathematical / statistical background and possibly some programming experience. • **Control engineer** for real time dispatch and monitoring of the network. • **System administrator** system and interface support, maintenance of master data, data cleansing.
WPD	Western Power Distribution

4 Related documents

Ref	Document title	Version	Date issued	Prepared by	Location
1	Revised_EFFS_FSP_Redacted_v2	2.0	06/07/2018	EFFS	Link
2	WPD_EFFS_DSO Requirements Specification_v1.0	1.0	24/05/2019	EFFS	Link
3	System Design Summary Report	2.0	25/10/2019	EFFS	Link
4	WPD EFFS_System Design_Capacity_Engine	2.0	25/10/2019	EFFS	Link
5	WPD EFFS_System Design_Market Interface	2.0	25/10/2019	EFFS	Link

5 System overview

5.1 Core functions overview

Figure 1 below is a diagrammatic representation of the functional areas within the EFFS project. The area that is the subject of this document is highlighted in red.

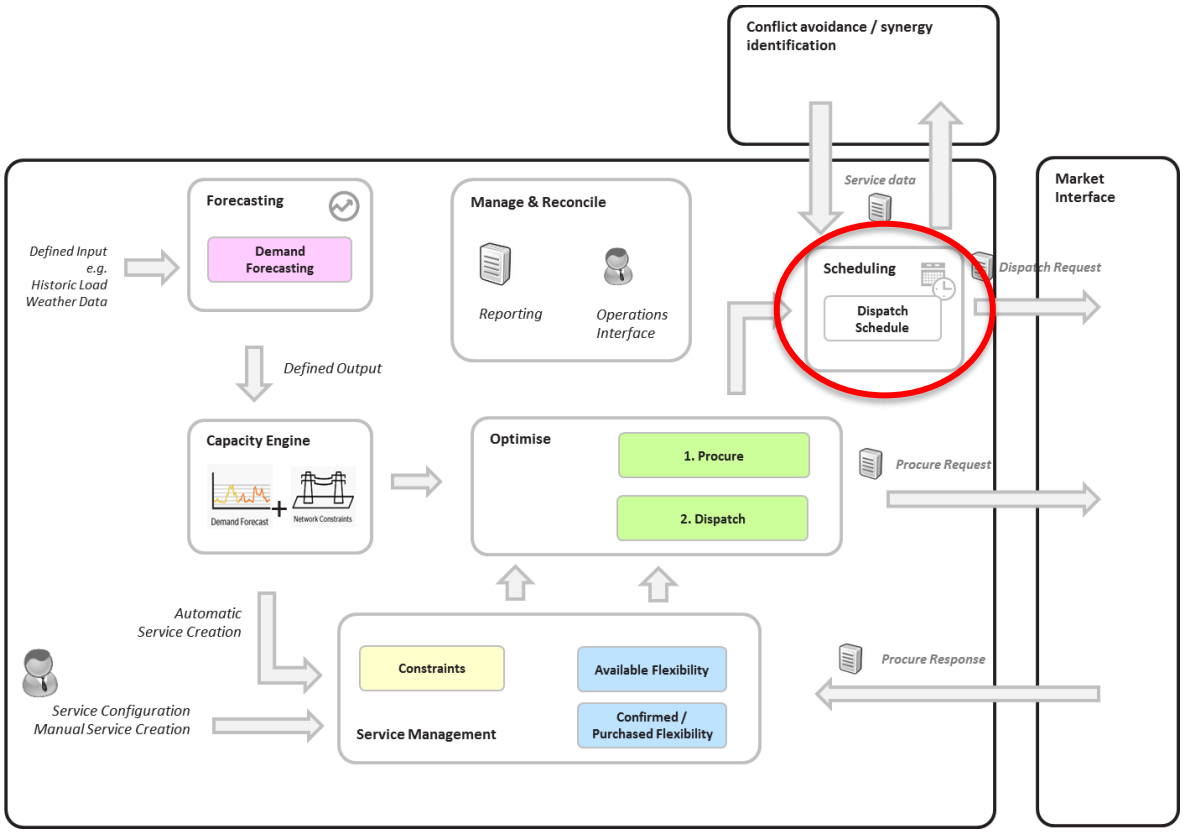


Figure 1: EFFS core functions

6 Scheduling

The scheduling function of EFFS involves the management of timed data exchanges over the market interface. These timed interactions then result in updates to the services recorded in the service register.

6.1 Scope

In scope	Out of scope
• Confirmation of scheduled services required i.e. the outcome of the two optimisation types: procurement and dispatch; and • Conversion and validation of the output from the optimisation module to create a schedule for publishing requirements to third party market interfaces.	• Direct scheduling of flexibility equipment.

Table 1: Scope for scheduling

6.2 Assumption

Scheduled flexibility services, where assets are dispatched against an agreed timetable, will not be dispatched via the scheduling module. It is expected that a local control system is suitably reliable for services that run on a routine basis without reference to actual network conditions and therefore introducing the communications network requirement for dispatch via EFFS is superfluous. Scheduled services will still be recorded in the EFFS service register for reporting purposes and so their impact can be taken into account in the capacity engine.

6.3 Description

Flexibility services are procured and dispatched via messages sent to the various flexibility platforms via the market interface. Information sent back from these platforms this also arrives at EFFS via the market interface. We expect the results from the market platforms to provide us with greater volumes of potential service than we require and therefore we use an optimisation process to select the best combination of possible services from the options provided. Please see 'WPD EFFS_System Design_Optimisation' for further detail.

The output of the optimisation process is a selection of bids to be accepted or services to be dispatched. Once these notifications are accepted, this updates the service register / calendar. While for the pre-fault constraint management service, there will be time to optimise the assets for dispatch and to issue notifications in advance, the situation for dispatching post-fault services will be limited to what can be provided realistically in real time. For example, optimisation that involves real-time power-flow analysis within EFFS would be impractical for restoration support service because the switching activities would result in a moving target when trying to replicate the network configuration in PSS®E[2].

[2] https://new.siemens.com/global/en/products/energy/services/transmission-distribution-smart-grid/consulting-and-planning/pss-software/pss-e.html

The post-fault services to be dispatched are highly dependent on the fault event that has occurred and how the network has been reconfigured after the fault has occurred (for example as a result of automatic switching). It may be possible to automatically dispatch post-fault services where the event that has occurred and the network configuration match one of the contingencies modelled in the requirements analysis and the actual power flows on the network are within a certain tolerance of the forecast values. Otherwise the dispatch of flexibility services is likely to require human intervention.

The key decision in this area was whether a user would want to be able to view and dispatch flexibility within EFFS or in PowerOn. The latter was the consensus position reached in the associated project workshop. This was based on the thinking that it would be inefficient for the control room users (who would be dispatching the post-fault services in near real time and then monitoring the network) to use two systems rather than PowerOn only.

This does however lead to the additional complication of integration with PowerOn and some inefficiency, as the signal will go via EFFS and the flexibility platform, which may not be performant. The details of the information presented within PowerOn is detailed in section 6.4.4.3 and the process to dispatch services is outlined within the document 'WPD EFFS_System Design_Market Interface'.

Figure 2 provides a representation of the dispatch mechanism for post fault services:

Figure 2: Representation of the dispatch mechanism for post fault services

A Control Engineer will be able to view available flexibility services within PowerOn and select the service that they require to be dispatched. Information is then passed via EFFS to the flexibility platforms relating to those services to notify the requirement to dispatch. The flexibility platforms are then responsible for forward transmission of the dispatch instruction which may involve direct control of an asset or passing on further messages to the aggregator and/or asset manager responsible for the asset.

There are manual approval steps included for both the approval of the proposed and confirmed service calendar. This is unlikely to be scalable across the whole of WPD's network licence areas but for the limited trials within EFFS is a sensible control / validation step. Therefore, the manual validation steps are configurable.

6.4 Solution

6.4.1 Pre-requisites

The pre-requisites for the scheduling solution stem from the optimisation solution. This is depicted in Figure 3 below:

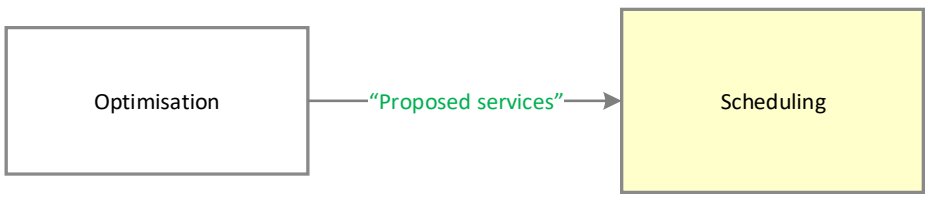


Figure 3: Optimisation and scheduling relationship

The optimisation module can provide a proposed solution to the constraint.

6.4.2 Input

The scheduling solution requires the following inputs:

- The optimisation module will provide the proposed chosen services and associated delivery profiles that best satisfy the forecasted network requirements as per the specified optimisation parameters. This will be a full Half Hourly (HH) profile of energy requirements that a service consists of rather than per individual HH.

6.4.3 Output

The scheduling module will produce the following outputs:

- The approved chosen services and associated delivery profiles that best satisfy the forecast network requirements as per the specified optimisation parameters to be communicated to the relevant flexibility platforms (see 'WPD EFFS_System Design_Market Interface' for details);
- Updating of the chosen services and their details in the service register;
- Visibility of all flexibility services within PowerOn; and
- Notification to third parties to support conflict identification and resolution / allow suppliers to reduce their imbalance.

6.4.4 User approval

6.4.4.1 Procurement

Whether the approval of the output of optimisation for procurement requires user approval is a parameter set globally for the procurement process. During the EFFS trials this manual approval step will be in place. When a manual approval parameter is set the proposed service selection with be re-evaluated through the capacity engine process with the proposed service selection considered as well as the other confirmed items in the service register (see 'WPD EFFS_System Design_Capacity_Engine' for details). The user will review the output of the Capacity Engine to ensure that the originally identified constraints have been resolved and no other network issues have been created.

When the constraints in the modelled network area have been resolved then the selection will be approved and added to the service register. Following this a procurement selection signal will be sent to the relevant flexibility platforms (see 'WPD EFFS_System Design_Market Interface' for details) and to PowerOn where the service type / flexibility platform does not support a dispatch phase. Where there are network issues, an iterative process to update the proposed services will be initiated until the constraint is resolved.

This process is illustrated below in Figure 4.

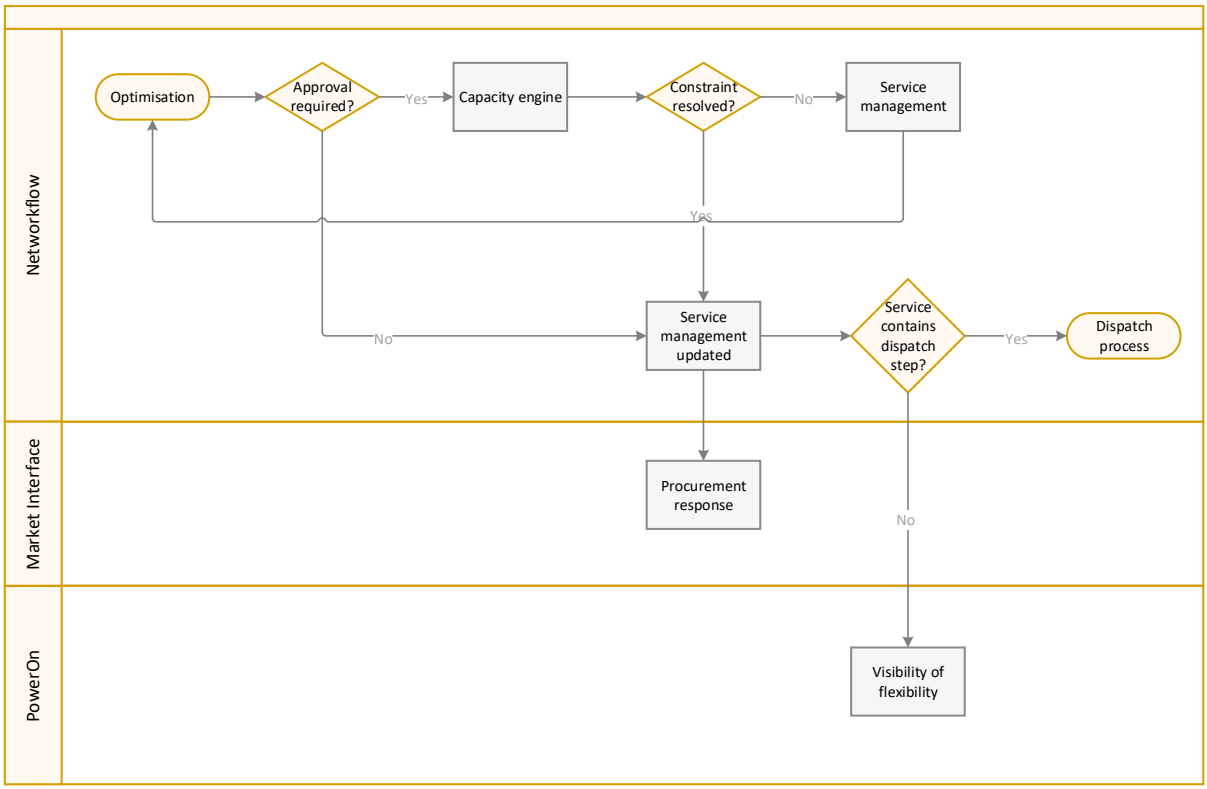


Figure 4: Procurement scheduling process

6.4.4.2 Dispatch

Whether the approval of the output of optimisation for dispatch requires user approval is a parameter set globally for the dispatch process. During the EFFS trials this manual approval step will be in place.

When the manual approval parameter is set the proposed service selection with be ran back through the capacity engine process (see 'WPD EFFS_System Design_Capacity_Engine' specification for details) at which point a user will review the output to ensure that the originally identified constraints have been resolved and no other network issues have been created.

When a constraint has been resolved then visibility of the flexibility to be dispatched will be passed to PowerOn, see section 6.4.4.3 and 8 for details. This is for visibility only for the scheduled constraint management and pre-fault constraint management. For the post-fault constraint management and restore service then dispatch will be triggered from PowerOn.

When it is not an iterative process to update the proposed services, it will be initiated until the constraint is resolved.

This process is illustrated below in Figure 5.

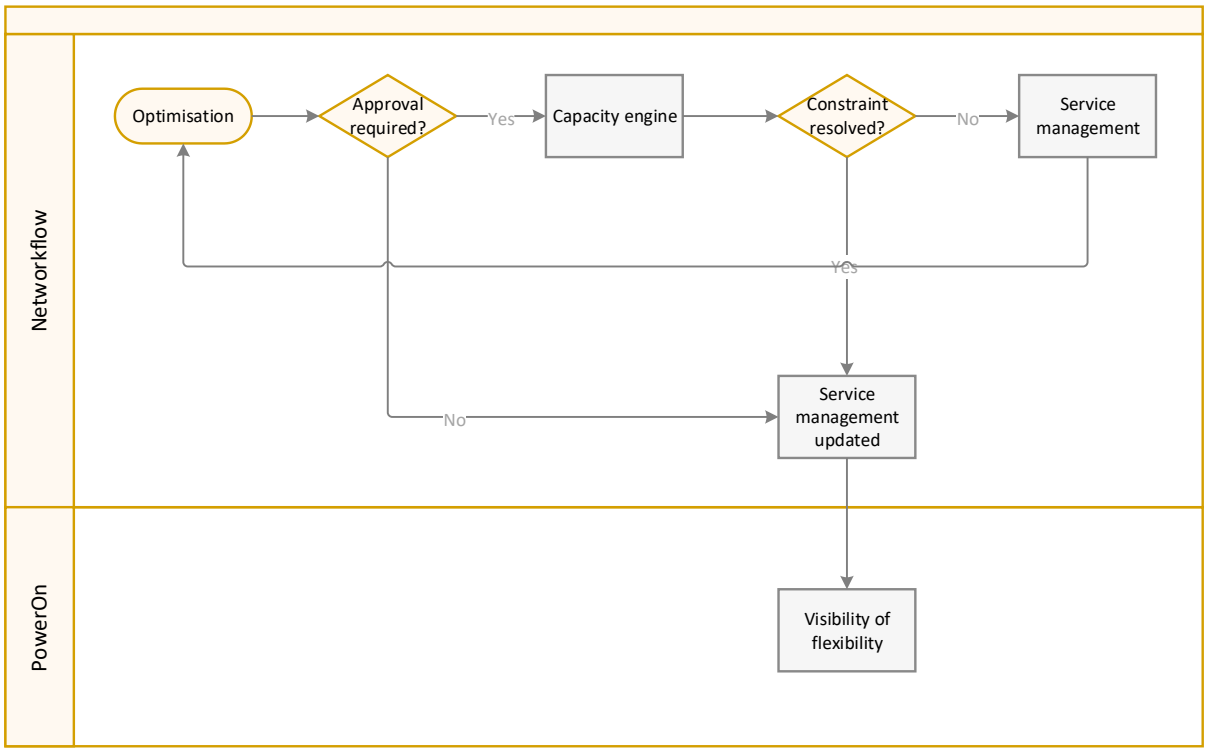


Figure 5: Dispatch scheduling process

6.4.4.3 Visibility of flexibility in Power On

EFFS will have users that will use it to manage flexibility services in a planned way ahead of real time using the EFFS system. However, for post-fault services in particular, it is important to have a facility for Control Engineers to be able to view and dispatch services directly from PowerOn as it is not practical for Control Engineers to switch between PowerOn and EFFS. Similarly, trying to align the EFFS model with PowerOn in real-time during multiple-fault scenarios could place a burden on PowerOn at a critical time.

Visibility is enabled via the feature for documents as a diagram element that is associated with assets on the PowerOn diagram.

1. Once a flexibility service is ready for dispatch (or has been procured if the associated service type / platform does not contain a dispatch step) PowerOn will need visibility of the procured service and the following data will be received from EFFS in the standard JSON format (see section 7 and 8.1 for details)
2. This data will be held in a table and be displayed on the PowerOn HV Diagram assigned to a document (Diagram element) against the site where the generation will be fed back into the network / site of load reduction.
3. Along with this information PowerOn will require an expiry date so each Flexibility Service can have a full life cycle.
4. Once the flexibility service has expired, deleted, cancelled or completed this information will need to be interfaced back to EFFS.
5. A [redacted] will be created to take the data from EFFS and place the documents down on the HV Diagram.

This is expected to be visualised in PowerOn as appropriate.

6.4.4.4 PowerOn to EFFS Dispatch Signal to market interface

EFFS will have users that will use EFFS to manage flexibility services in a planned way ahead of real time using the EFFS system. However, for post-fault services in particular, it is important to have a facility for Control Engineers to be able to view and dispatch services directly from PowerOn as it is not practical for Control Engineers to switch between PowerOn and EFFS. Similarly, trying to align the EFFS model with PowerOn in real-time during multiple-fault scenarios would likely place a risky additional burden on the PowerOn system.

It is envisaged that a document on the PowerOn HV diagram will have an 'activate \ apply' button which when activated will send a trigger mechanism to EFFS which will then dispatch the flexibility services to the flexibility platform and a cancel button, so control engineers can cancel the service if required. This could be achieved by [redacted] as they are thought to be the best way of achieving this.

When the signal is received from PowerOn, EFFS will dispatch the relevant Flexibility Platform using a dispatch message (as detailed in 'WPD EFFS_System Design_Market Interface').

6.5 Changes since DSO requirements document baselined

Due to the removal of the dispatch step for a couple of services and flexibility platforms the point at which flexibility services will be visible from PowerOn has changed. Previously they would only be visible at the point immediately after dispatch optimisation for all services. Now the point at which services is visible in PowerOn is dependent on the service type and flexibility platform (e.g. EDFs PowerShift or CLEM does not support a dispatch phase, therefore the visibility of flexibility services will be pushed to PowerOn post procurement optimisation.

Also, in the 'WPD_EFFS_DSO Requirements Specification_v1.0' it was defined that control room users would need visibility of the market prices to inform their manual dispatch decisions of flexibility services. However, given control room engineers do not use pricing information into account in their decision making this data exchange has been removed.

7 Interfaces

Figure 6 provides an overview of the interfaces to be implemented in support of the EFFS scheduling solution.

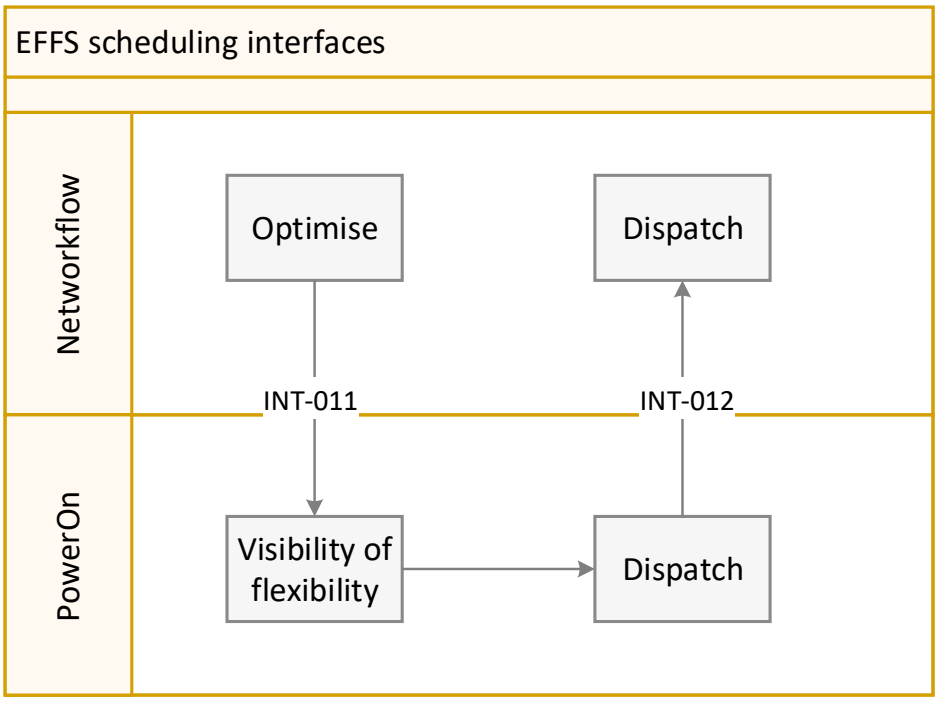


Figure 6: EFFS scheduling interfaces overview

Details of these interfaces are provided in Table 2.

Interface	Source system	Target system	Type	Frequency	Data
INT-011	Networkflow[3]	PowerOn	[redacted]	Ad hoc	Visibility of flexibility services available for dispatch
INT012	PowerOn	Networkflow	[redacted]	Ad hoc	Dispatch signal

Table 2: INT-011 details

[3] https://www.amt-sybex.com/networkflow/

8 Data items

The following section lists the data items to be contained in INT-011 and INT-012 as described in Section 6.

The interfaces are described in an indicative logical fashion rather than physically as this information is proprietary. The detailed physical interfaces will be agreed during the build phase of EFFS.

8.1 INT-011: Visibility of flexibility services available for dispatch

Data item	Type	Units	Cardinality	Valid set value	Notes
Transaction type	VARCHAR(50)	N/A	1	'Visibility of flexibility services available for dispatch'	
Transaction ID	NUMBER(10)	Numeric	1		Unique ID for the transaction. Should be included in any related responses generated by the generating system.
Transaction Datetime	TIMESTAMP	Timestamp	1		Date and Time when the request was created in the following format 'YYYY-MM-DD HH24:MI:SS.FF'
PowerOn Equip ID	VARCHAR(14)	N/A	1		Unique industry identifier for the equipment
Service type	VARCHAR(4)	N/A	1	'SCM' 'PRCM' 'POCM' 'RS'	'SCM' = Scheduled constraint management' 'PRCM' = 'Pre-fault constraint management' 'POCM' = Post-fault constraint management' 'RS' =

Data item	Type	Units	Cardinality	Valid set value	Notes
					'Restoration Support'
HH Datetime	TIMESTAMP	Timestamp	1-*		This will be defined by a DATE + TIME of the end of the HH period. Where HH datetime is less than current date time POF will remove this entry.
Value	NUMBER(10,3)	MW	1-*		

Table 3: Data types for INT-011

8.2 INT-011: Dispatch signal

Data item	Type	Units	Cardinality	Valid set value	Notes
Transaction type	VARCHAR(50)	N/A	1	'Dispatch signal'	
Transaction ID	NUMBER(10)	N/A	1		Unique ID for the transaction. Should be included in any related responses generated by the generating system.
Transaction Datetime	TIMESTAMP	N/A	1		Date and Time when the request was created in the following format 'YYYY-MM-DD HH24:MI:SS.FF'
PowerOn Equip ID	VARCHAR(14)	N/A	1		Unique industry identifier for the equipment
Service type	VARCHAR(2)	N/A	1	'SCM' 'PRCM' 'POCM'	'SCM' = Scheduled constraint management'

Data item	Type	Units	Cardinality	Valid set value	Notes
				'RS'	'PRCM' = 'Pre-fault constraint management' 'POCM' = Post-fault constraint management' 'RS' = 'Restoration Support'
HH Datetime	TIMESTAMP	Timestamp	1-*		This will be defined by a DATE + TIME of the end of the HH period. Where HH datetime is less than current date time POF will remove this entry.
Value	NUMBER(10,3)	MW	1-*		
Action	VARCHAR(1)	N/A	1-*	'D' 'C'	'D' = 'Dispatch' 'C = 'Cancel'

Table 4: Data types for INT-012

9 Contact

If you have any questions relating to this document, please use the following points of contact:

Future Networks Team:

Western Power Distribution,
Pegasus Business Park,
Herald Way,
Castle Donington,
Derbyshire
DE74 2TU

Email: jwoodruff@westernpower.co.uk

Appendix 1: Definition of Flexibility Platform

'Flexibility Platform' is a term used throughout this document and is deliberately generic due to the current lack of cross-industry consensus on what this role entails and the differences between the existing platforms. Whilst it is not the purpose of EFFS to specify how these platforms will operate, the project makes various assumptions about what functions they will perform throughout the document. For ease of reference these are collated in the table below. Please note that this list is not an exhaustive; it is an overview of assumed flexibility platform capabilities and their relationship to EFFS.

Function	Carried out by flexibility platform?	Required by EFFS?
Interface for registering flexible resources	Yes	Yes
Allows buyers and sellers to match their requirements	Yes	Yes
Communication with flexibility resources	Yes	Yes
Dispatch of flexibility resources	Yes	Yes
Commercial optimisation	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Conflict avoidance with other parties	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Synergy identification with other parties	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Settlements (payment of flexibility providers)	Yes	Yes
Measurement of flexibility providers performance	Yes	Yes

Table 5: Flexibility platform functions