

Why we have OPFs and don't use them



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17/1/2018

The short answer...

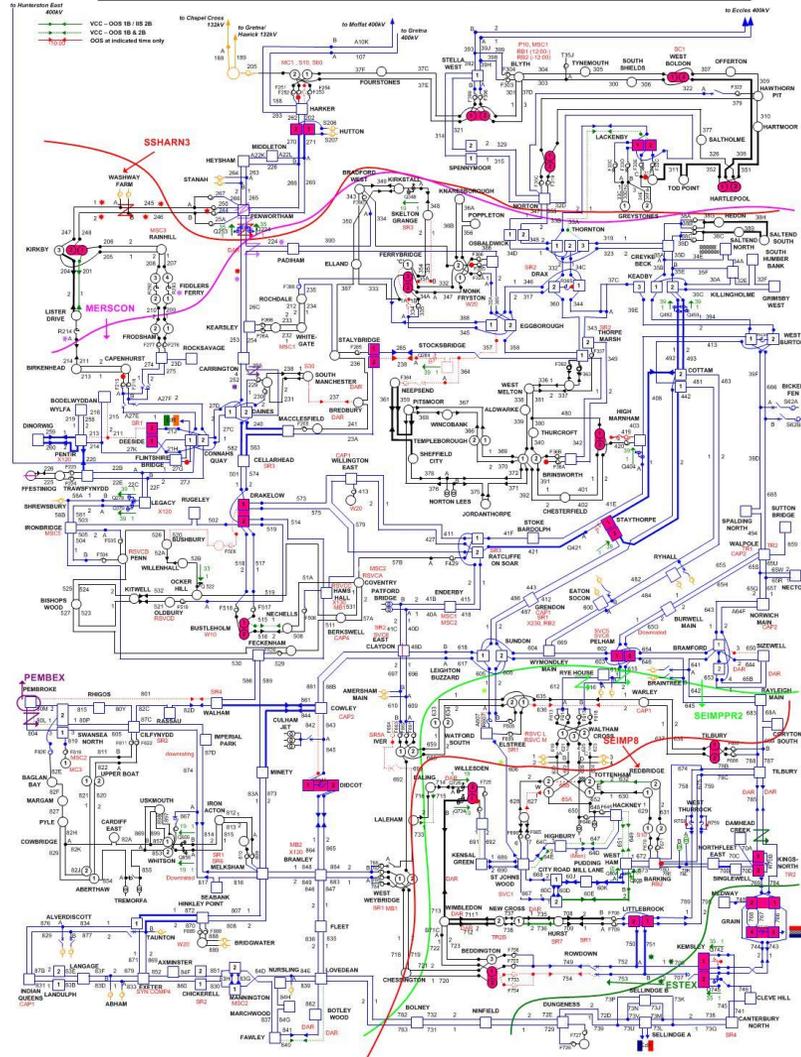
- Data!
- And the problem...
- And the people factors...
- And the processes...
- And the reliability requirements...
- And the time pressure...
- But mostly the data – so I'll concentrate on that.

(Actually, we do use an Optimal Power Flow, but only in planning and system design, not in operations).

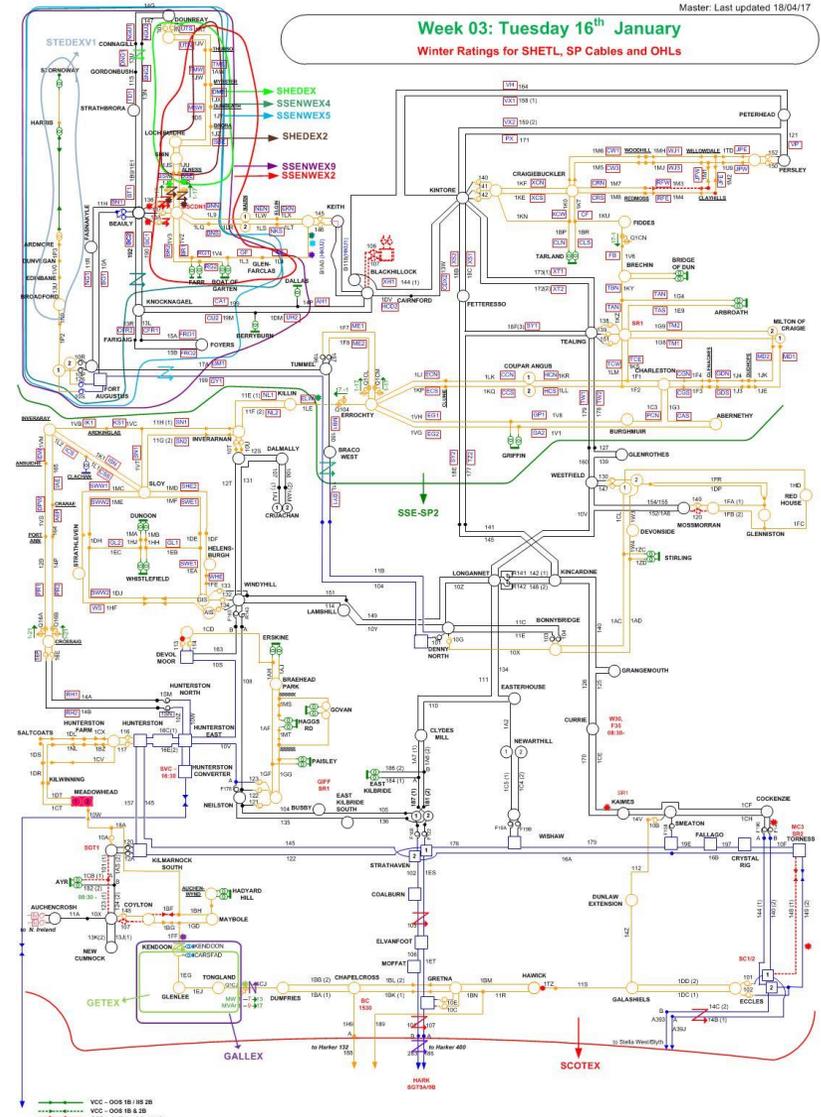
“IEMS” = Integrated Energy Management system

The Transmission Network: E&W and Scotland

Week 03: Monday 15th January 2018
Winter Ratings

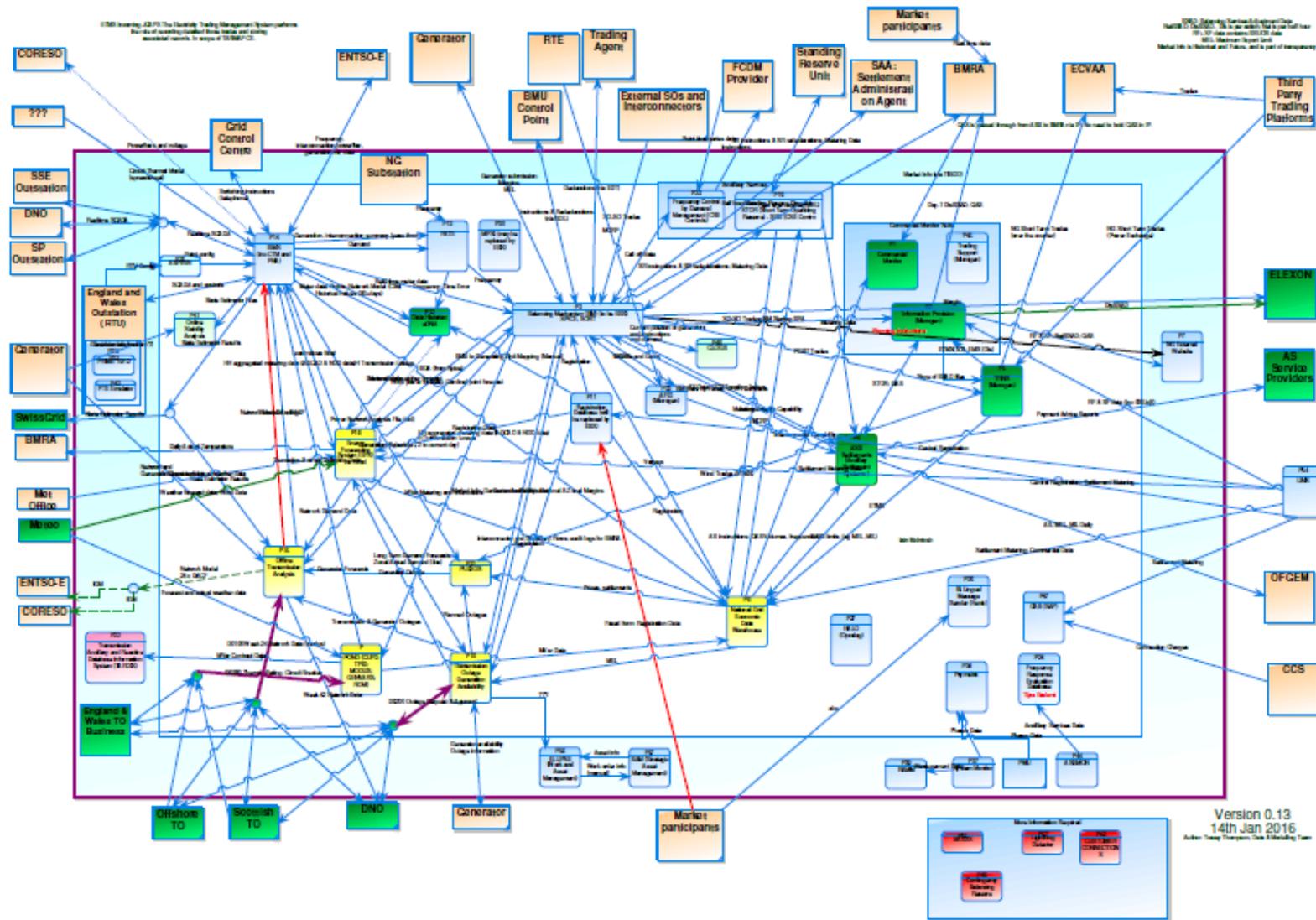


Week 03: Tuesday 16th January
Winter Ratings for SHETL, SP Cables and OHLs

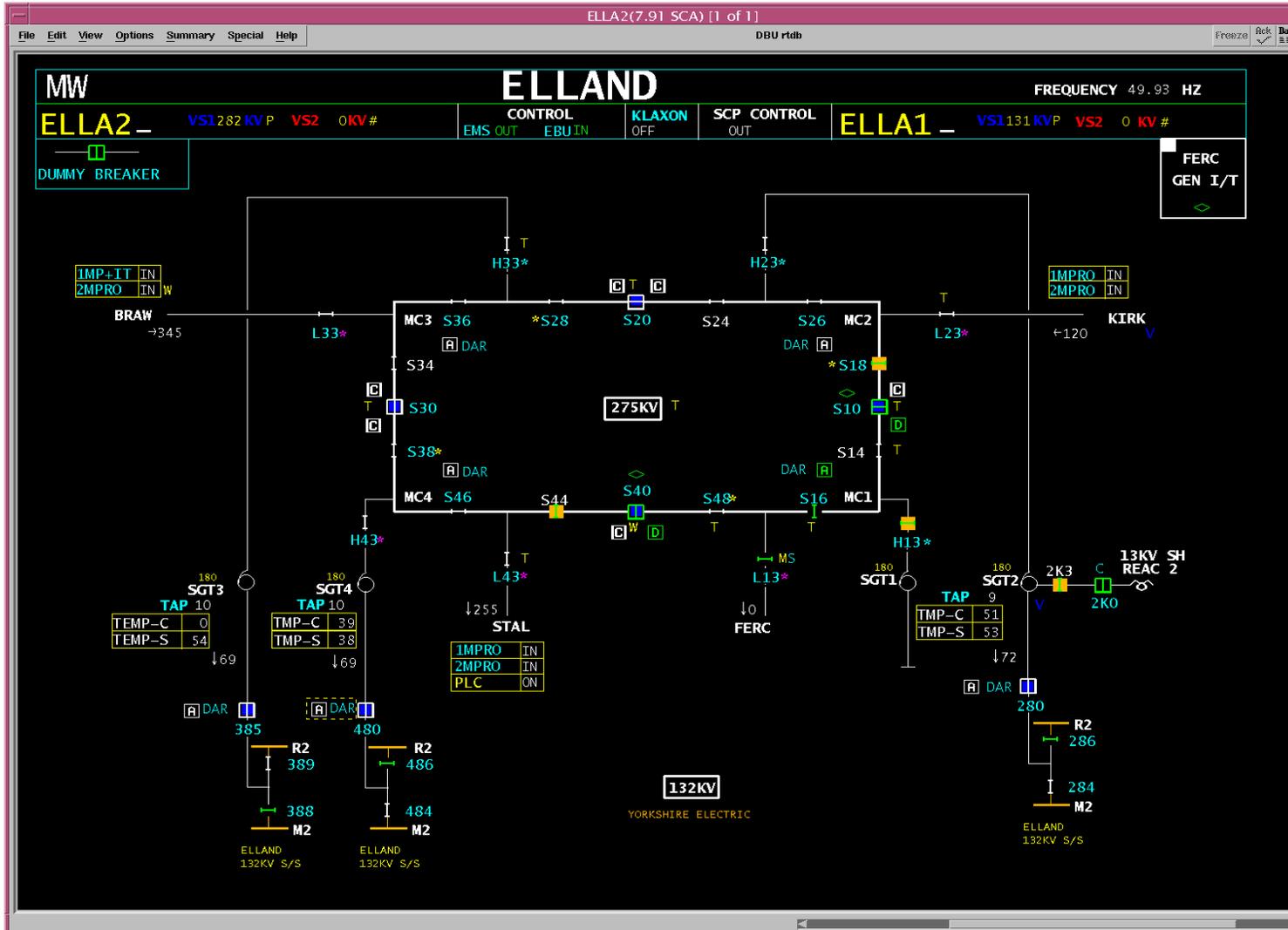


Master: Last updated 18/04/17

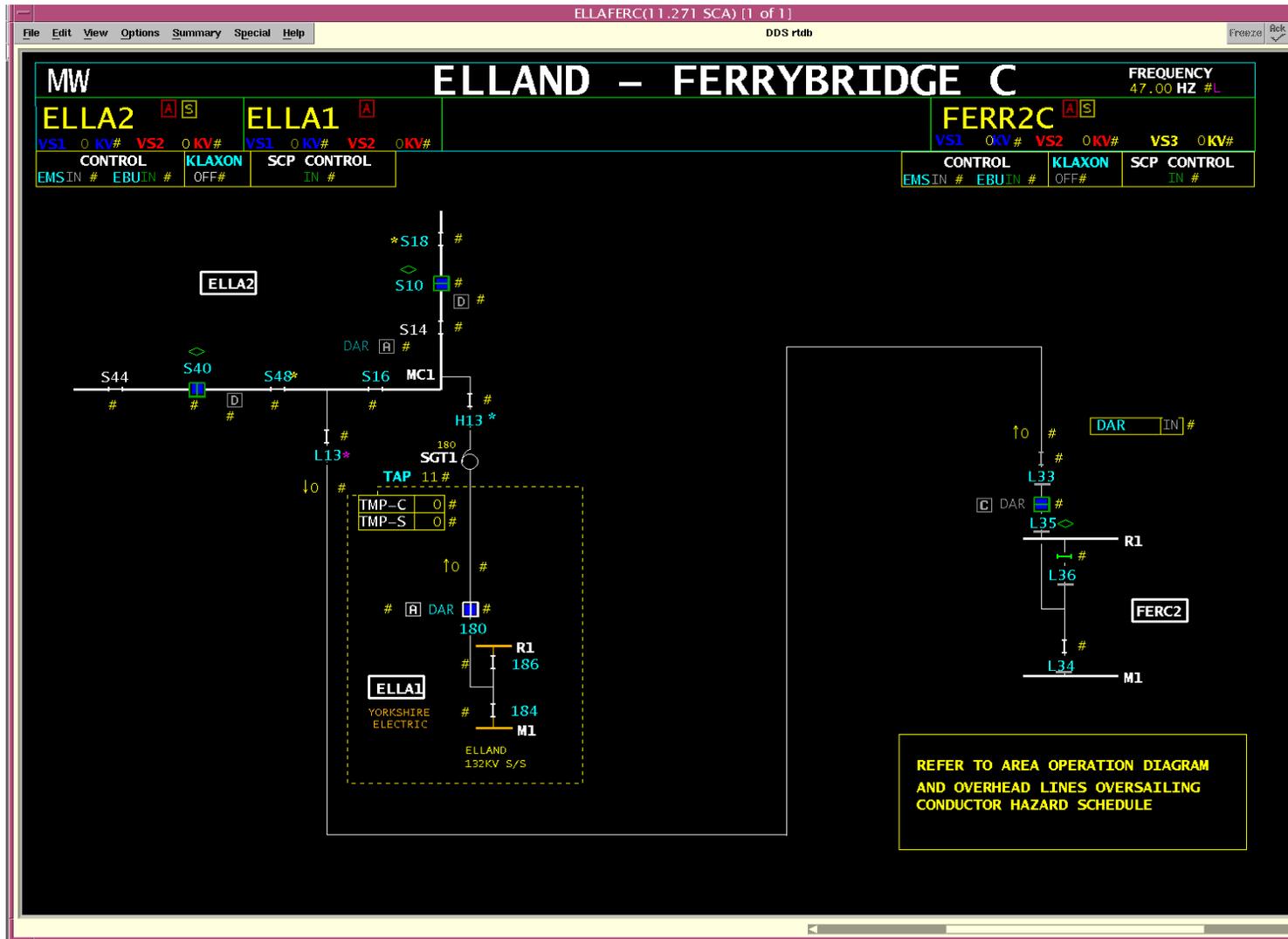
The Logical Data Flow network...



Adding a transformer at Elland 275kV substation



Revised Operational Circuit diagram



Tabular Displays: Power System

Sort Key:

Set Description

View Filter:

SCA CME APP PS

Description Filter:

Description: *

(15) Network Power System

Set View	Description
41	NETA SORT SUMMARY
25	NORTH AVC SUMMARY
6	NORTH HV DAR SUMMARY
7	NORTH LV DAR SUMMARY
3	NORTH ZONE BALANCING/CCGTS
21	PUMP STORAGE SUMMARY

Selection

NORTH AVC SUMMARY

STN	DESCRIPTION	STATUS
ALDW2	SGT1B	IN
	SGT1A	IN
	SGT2	IN
	SGT3	IN
	SGT4	IN
BIRK1	MB1	IN
	MB2	IN
	RB1	IN
	RB2	IN
BLYT1	A/L-1	IN
	A/L-2	IN
BLYT6	MB1	IN
	MB2	IN
	MB3	IN
	RB1	IN
	RB2	IN
	RB3	IN
BRAW1	MB1	IN
	MB2	IN
	RB1	IN
	RB2	IN
BRED1	MB1	IN
	MB2	IN
	RB1	IN
	RB2	IN
CAPE1A	MB1	OUT
	SGT1A	IN
	SGT3A	IN
CARR1	MB2	IN
	MB3	IN
	MB4	IN
	RB2	IN
	RB3	IN
	RB4	IN

NORTH LV DAR SUMMARY

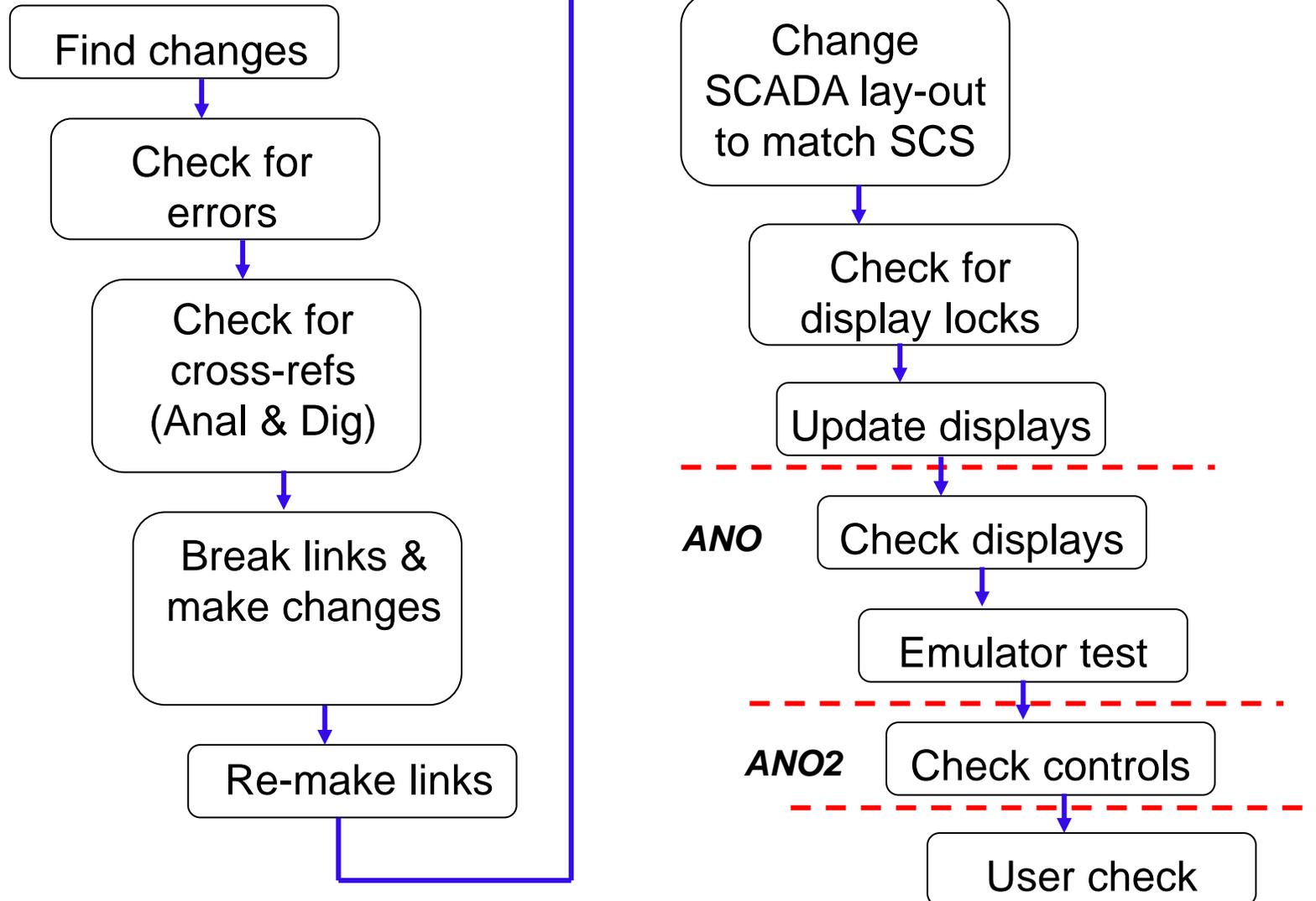
STN	DESCRIPTION	STATUS	STN	DESCRIPTION	STATUS	STN	DESCRIPTION	STATUS
BIRK1	SGT2A	IN	INCE1	505	IN	SALH1	180	IN
	SGT3	IN		605	IN		280	IN
	SGT4	IN	JORD3	SGT1	IN	SHEC3	SGT1	IN
BRAW1	180	IN		SGT2	IN		SGT2	IN
	280	IN	KIRK1	180	IN	SKLGL	SGT1	IN
	380	IN		280	IN		SGT2	IN
	480	IN		480	IN			IN
BRED1	SGT1	IN	LTSD1	SG				
	SGT2	IN		SG				
	SGT3	IN	MACC2	SG				
CAPE1A	SGT2A	IN	NORL3	SG				
CAPE2	H20	IN	NORT1	SGT				
CARR1	780	IN		SGT				
CHTE1	SGT1	IN	OFFE3	SGR				
	SGT2	IN		SGR				
	SGT3	IN	OSBA1	180				
	SGT4	IN		280				
ELLA1	180	IN	PERH1	10				
ELLN1	280	IN		20				
	385	IN	PITS3	SG				
	480	IN		SG				
FERR1B	580	IN		SG				
	480	IN		SG				
FROD1	280	IN	POPP3	SGI				
	380	IN		SGI				
	380	IN	RAIN1	180				
	280	IN		480				
GR1W1	180	IN	ROCH1	180				
	280	IN		280				
	380A	IN		380				
	380B	IN		380				
	480	IN	ROCK1	180				
	505	IN		180				
HUTT1	180	IN	SAEN1	SG				
	380A	IN		SG				

NORTH HV DAR SUMMARY

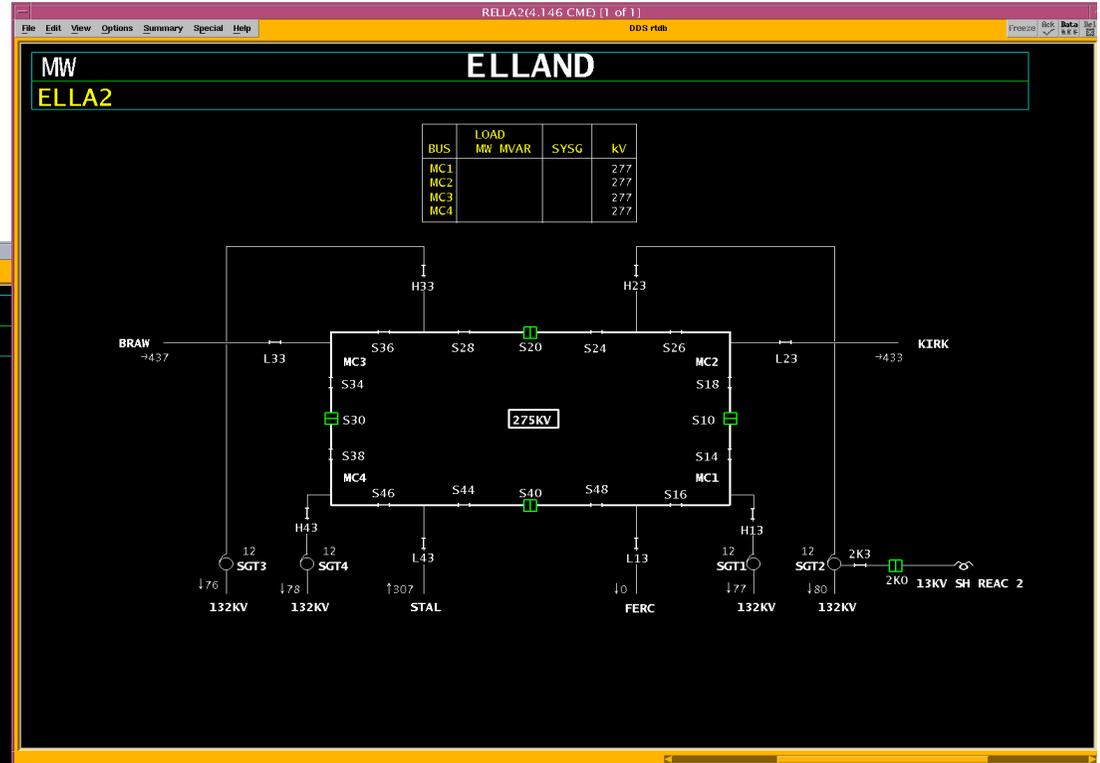
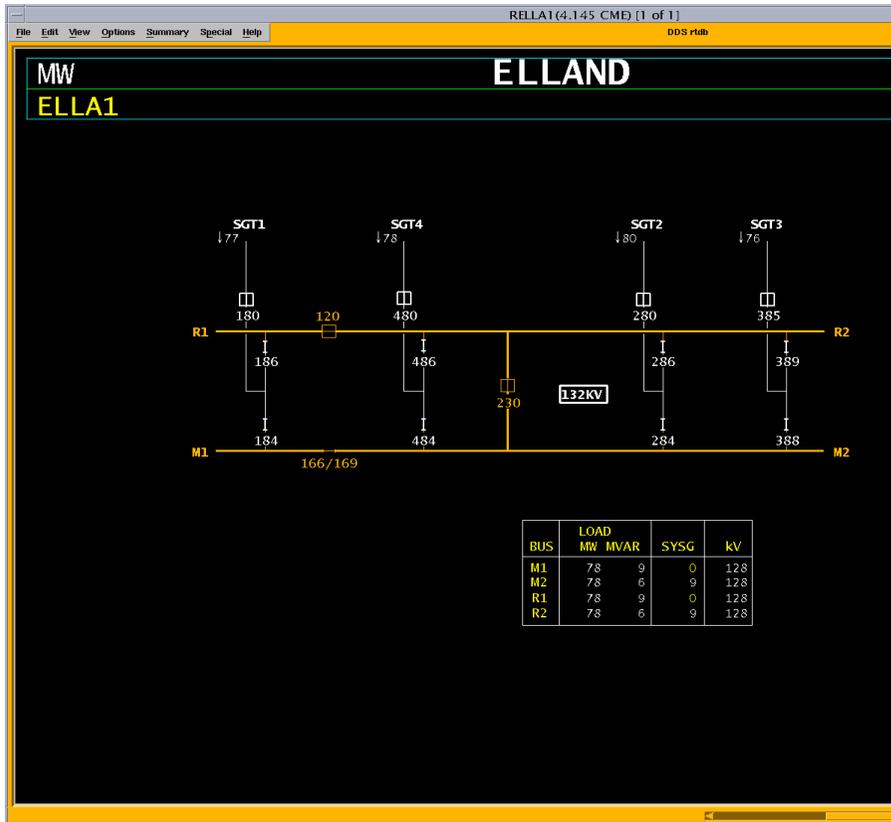
STN	DESCRIPTION	STATUS	STN	DESCRIPTION	STATUS	STN	DESCRIPTION	STATUS
ALDW2	MC1	IN	CAPE4	X505	IN	DEES4	PENT4-1	IN
	MC2	IN		X605	IN		PENT4-2	IN
	MC3	IN	CAPE2	BIRK2-2	IN		CAPE4-1	IN
	MC4	IN		BIRK2-1	IN		CAPE4-2	IN
BIRK2	MC2	IN		SGT5A	IN		DAIN4-1	IN
	MC3	IN		SG16A	IN		DAIN4-2	IN
	MC4	IN		INCE-2	IN		LE/TR-1	IN
BLYT2	STEW2-2	IN					LE/TR-2	IN
	STEW2-3	IN						
	SGT1A/2B	IN	CARR2	SMAN2-1	IN	DIN04	SITE	OUT
	TYNE2	IN		SMAN2-2	IN		PENT4-2	IN
	FOUR2	IN		DAIN2-1	IN			
	SSH/TYN	IN		DAIN2-2	IN	DRAX4	THTO4-2	IN
	SW1/SN3	IN	CARR4	X710	IN		THTO4-1	IN
	SGT3	IN					THRM4	IN
BRAW2	MC1	IN	CHTE2	MC1	IN		BR/KE4	IN
	MC2	OUT		MC2	IN		EGGB4-2	IN
	MC3	IN		MC3	IN		EGGB4-1	IN
	MC4	IN		MC4	IN			
BRED2	MC1	OUT	COTT4	STAY4-2	IN	EGGB4	DRAX4-1	IN
	MC2	IN		KEAD4-1	IN		DRAX4-2	IN
	MC3	IN		KEAD4-2	IN		ROCH4	IN
	MC4	IN		STAY4-1	IN		ST/NE4	IN
BRIN4	MC1	IN		EASO4-1	IN		FERR4C	IN
	MC2	IN		ES/RY-2	IN		THRM4	IN
	MC4	IN					MONF-2	IN
BRIN2	MC1	IN	CREB4	SAEM4	IN		MONF-1	IN
	CHTE2-1	IN		SAES4	IN			
	CHTE2-2	IN		HU/KE	IN			
	CHD2	IN		TH104-1	IN			
	JORD2	IN		TH104-2	IN	ELI42	MC1	IN
	NOR/SHE	IN		KE/K1	IN		MC2	IN
	TEMP2-1	IN					MC3	IN
	TEMP2-2	IN	DAIN4	DEES4-1	IN		MC4	IN
	THUR2	IN		DEES4-2	IN	FERR2	ELLA2	IN
	TINP2-1	IN		CARR4-1	IN		MONF2	OUT
	TINP2-2	IN		CARR4-2	IN		MF/FB-5	OUT
	SGT1	IN		CELL4	IN		SK/FB-4	IN
	SGT4	IN		KEAR4	OUT		SKLGA-2	IN
				CARR/PEWO	IN		SGT1A	OUT
				MACC4	IN		SGT1B	OUT

Ok
Dismiss

Adding an SGT into SCADA



Network Analysis displays

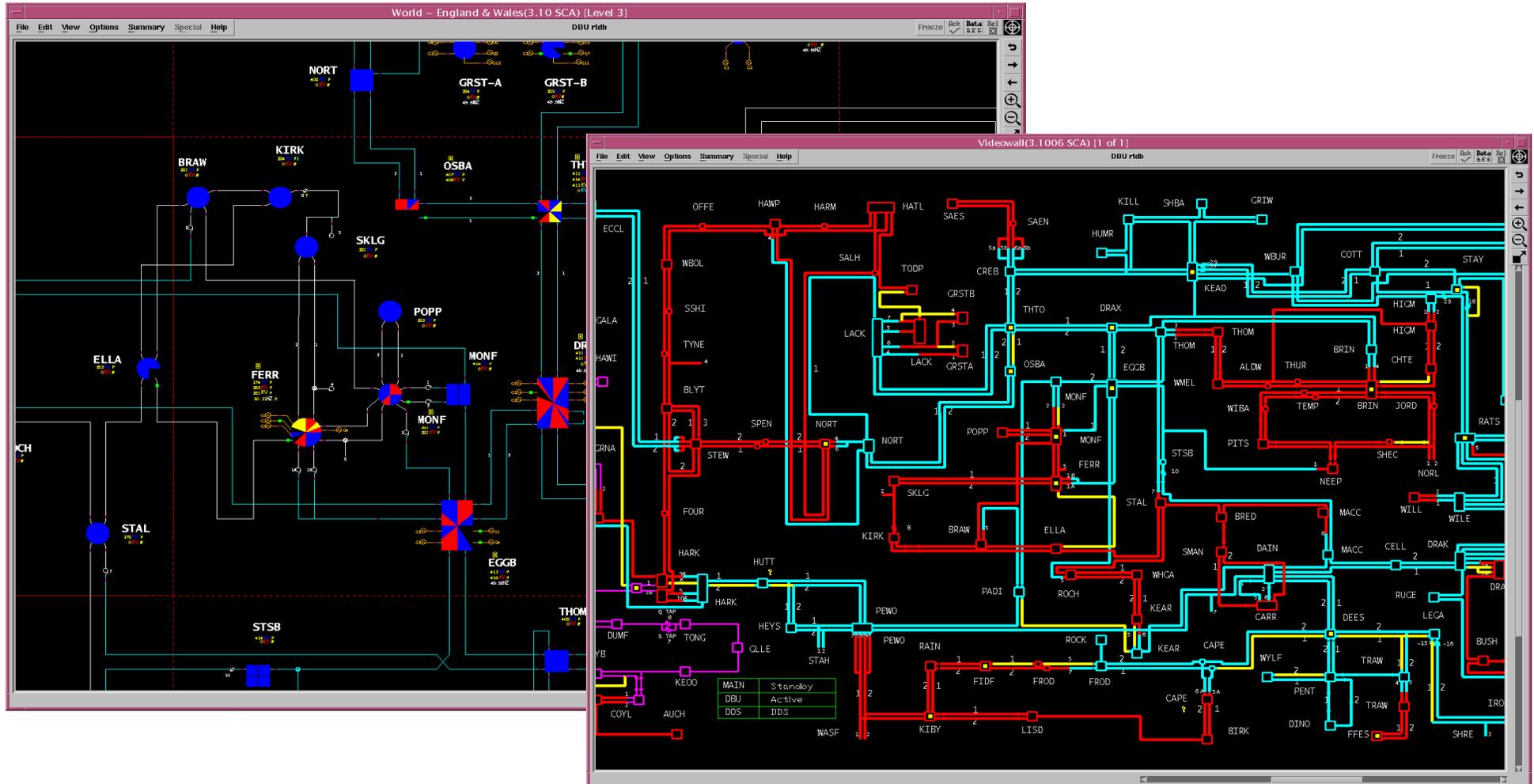


Adding an SGT into Network Analysis

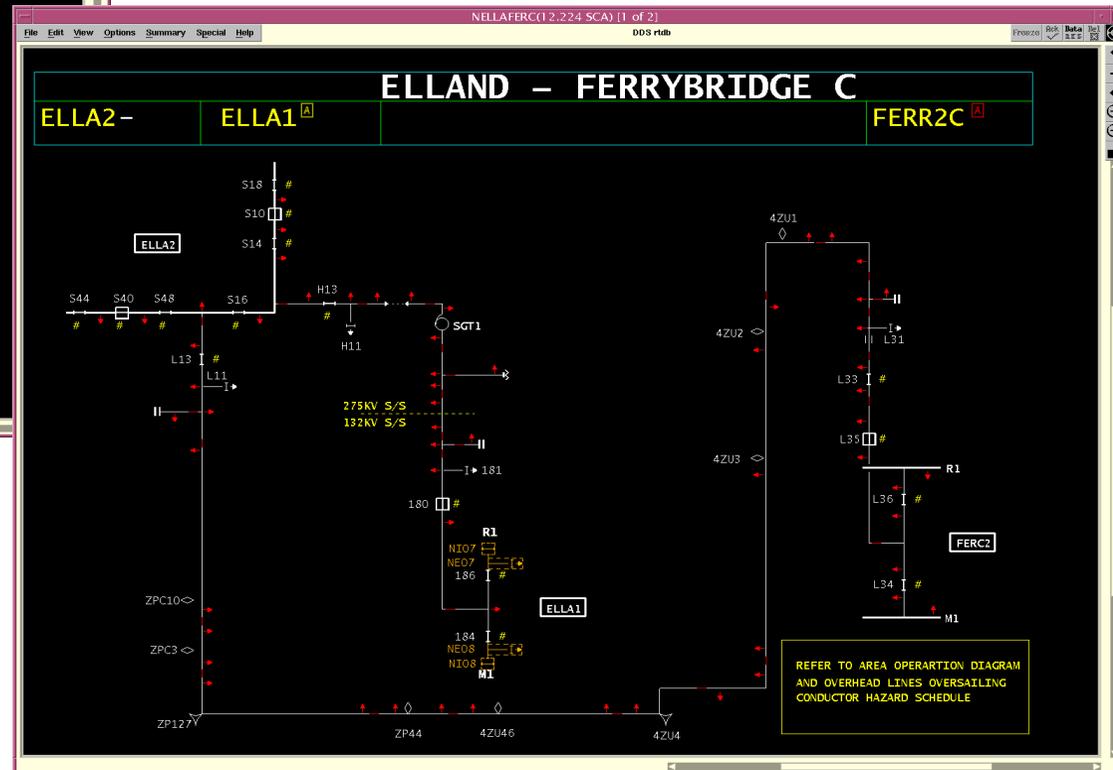
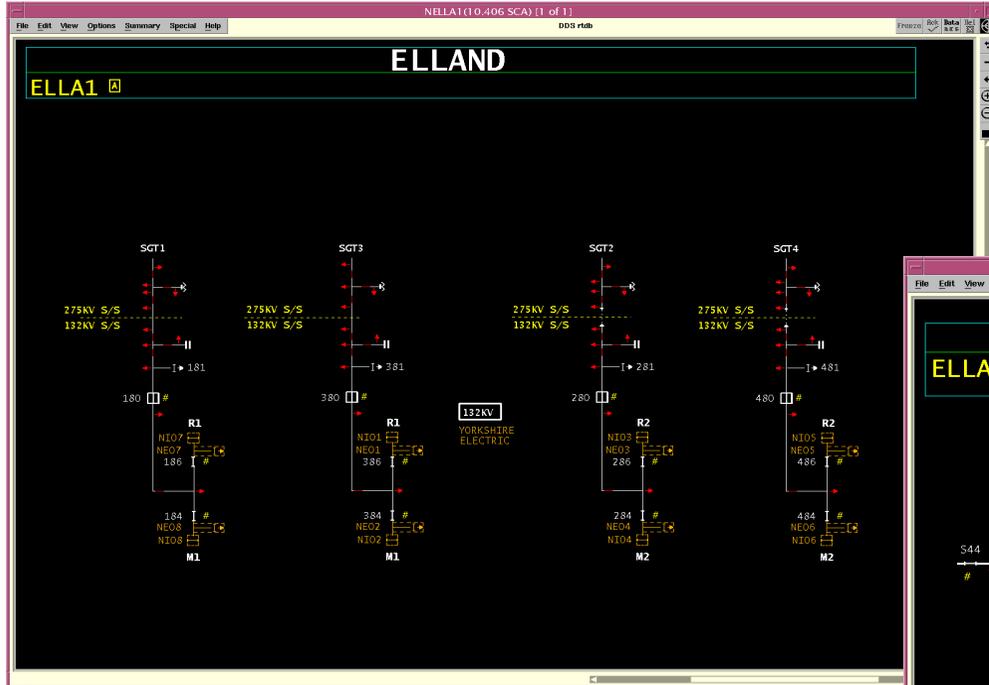
Similar process to SCADA, but with added data, eg:

- Tap range, thermal limits and impedances
- Bus section numbering scheme
- Create points for State Estimator output and calculated values (eg MVA)
- Create points for voltage selection scheme
- Add MW, MVA_r and MVA calculations into summations
- Update contingency list
- Line End Open calculations
- Data for external interfaces (EFS, Data Historian, Scottish TOs, DNOs, Coreso, ENTSO-E, Swissgrid, BM)
- Video wall display.

World and Videowall Views



And Safety....



Changes made in adding SGT

- 200 Status Points for GI74 (3-5 times more for IEC protocol).
- 30 Analogue Points.
- 1 Synchrocheck Assignment.
- 1 GI74 RTU layout
- Complex changes for Network Analysis
- 4 Calculations
- 4 CME Points
- Data transfer to external systems

So all in all:

- **~10 days work over 4 weeks**
 - **Almost the same amount of work to back out the change**
(displays backed out for delay >1 week; database changes >1 month)

This is why we have 32 people working on real-time data management...



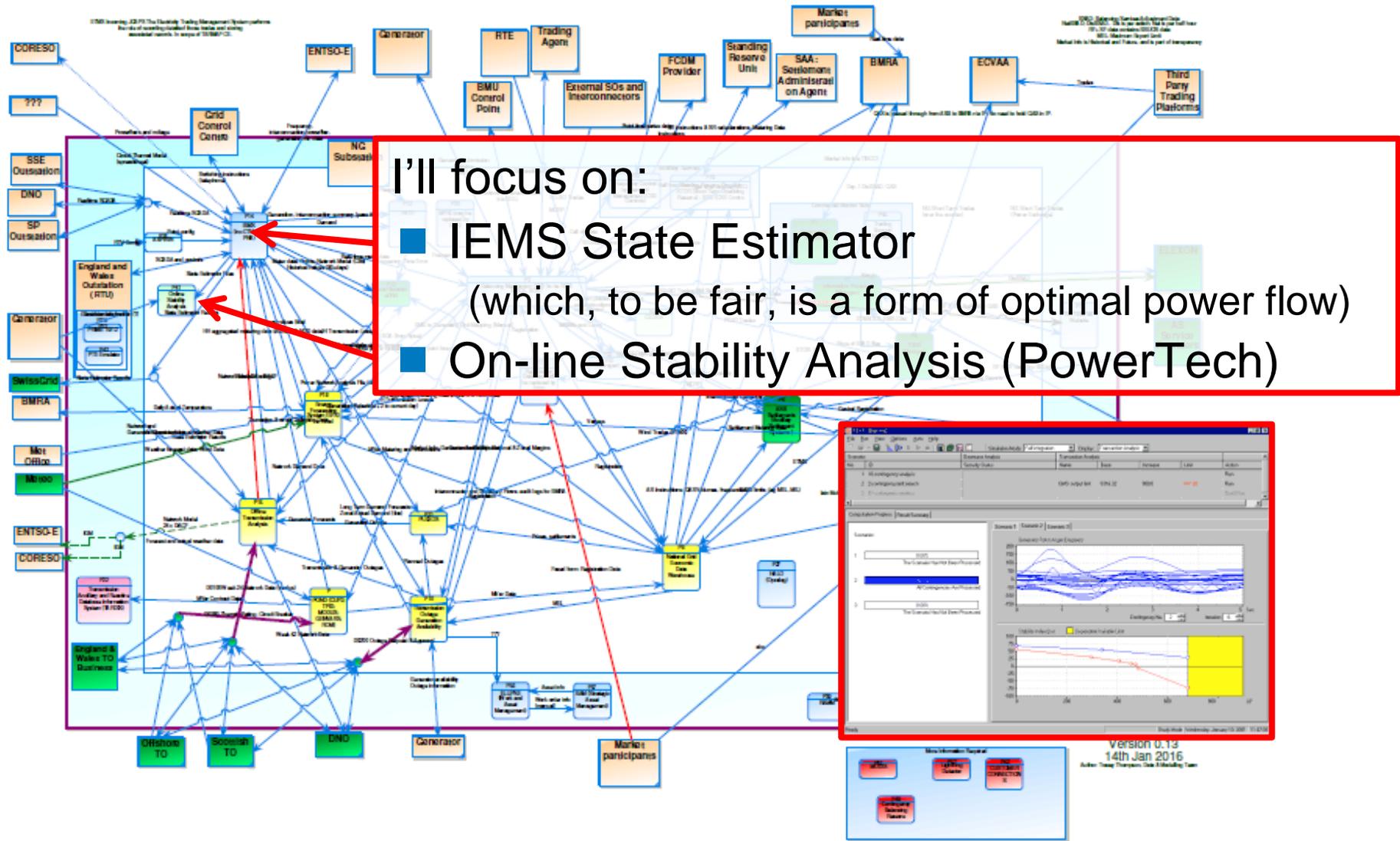
IEMS “Commit” room



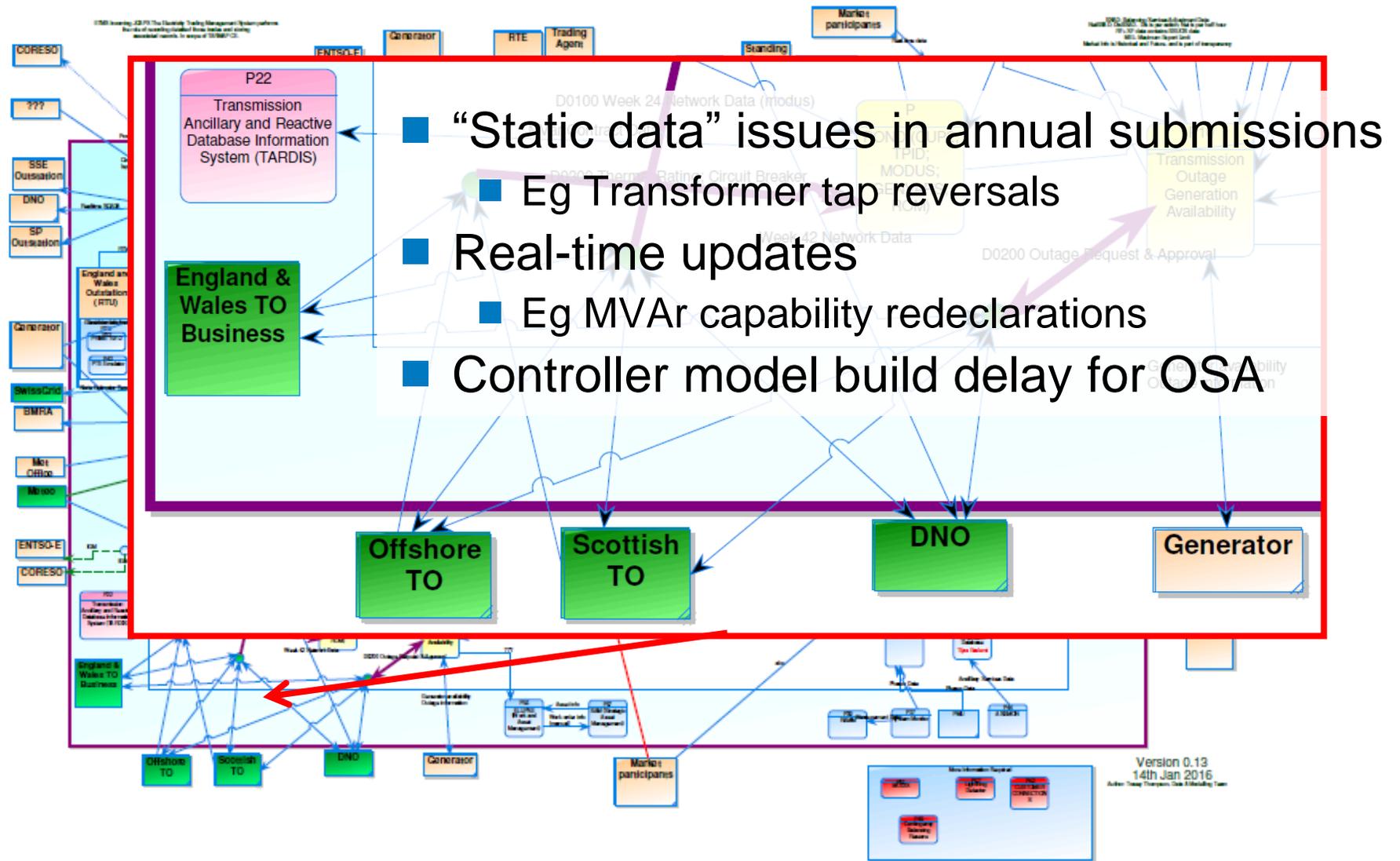
Data changes are made on a separate instance of the IEMS and tested with an emulator.

Then commit to Active first, followed by Standby the next day.
Changes being committed 9+ hours per day, 5 days/week. (A full substation takes about 2½ hours)

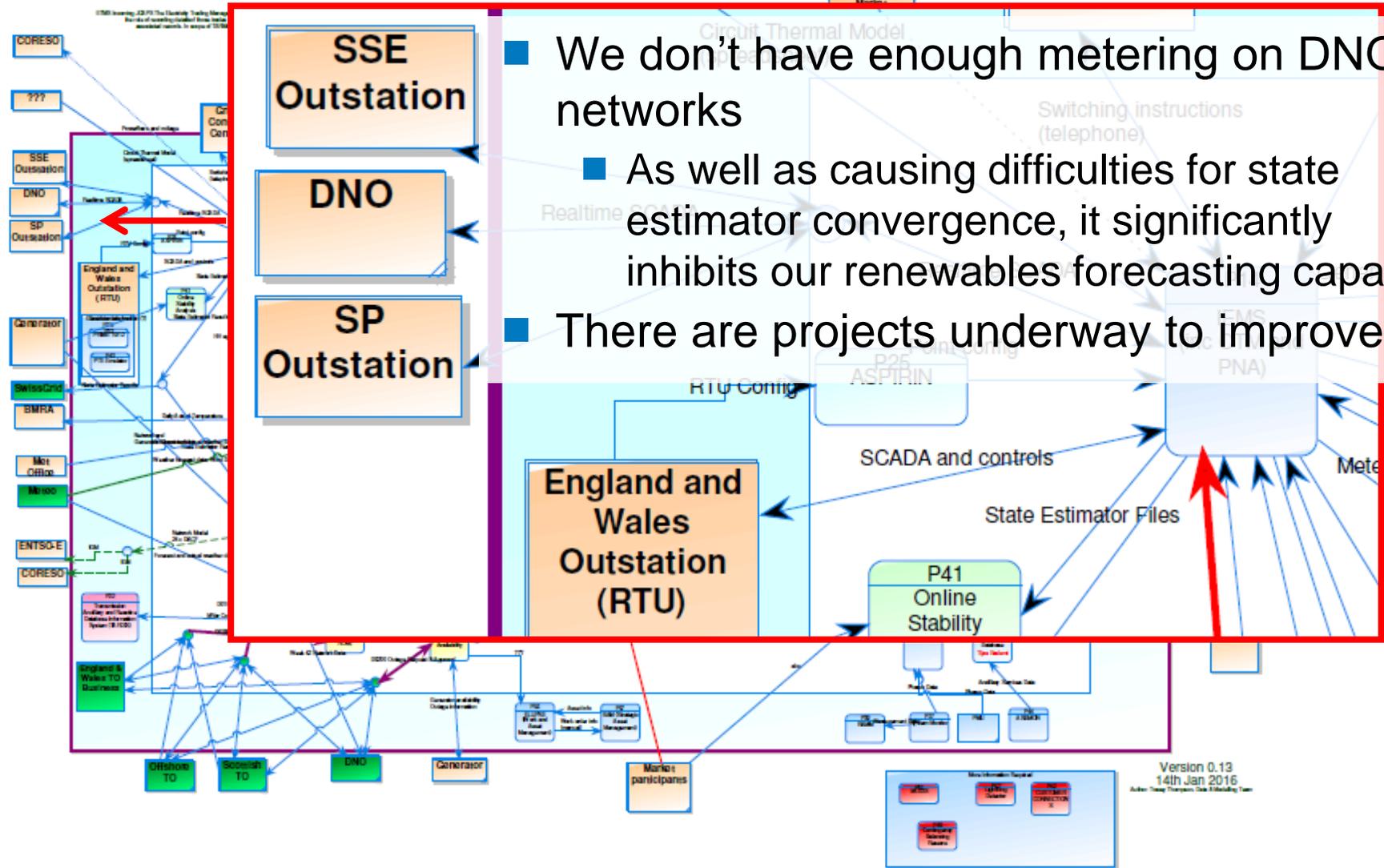
So what kind of data problems do we have?



External data providers

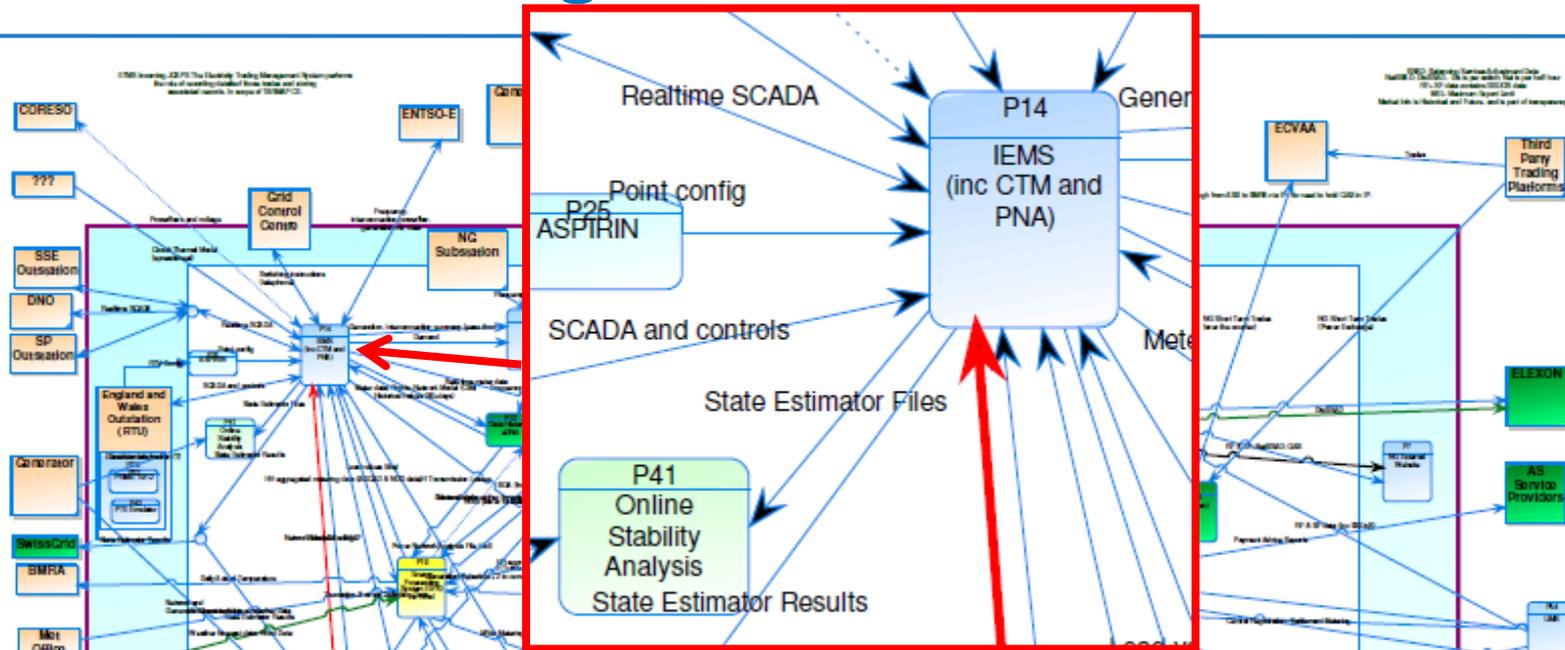


Real-Time Metering deficit



- We don't have enough metering on DNO networks
 - As well as causing difficulties for state estimator convergence, it significantly inhibits our renewables forecasting capability
- There are projects underway to improve this

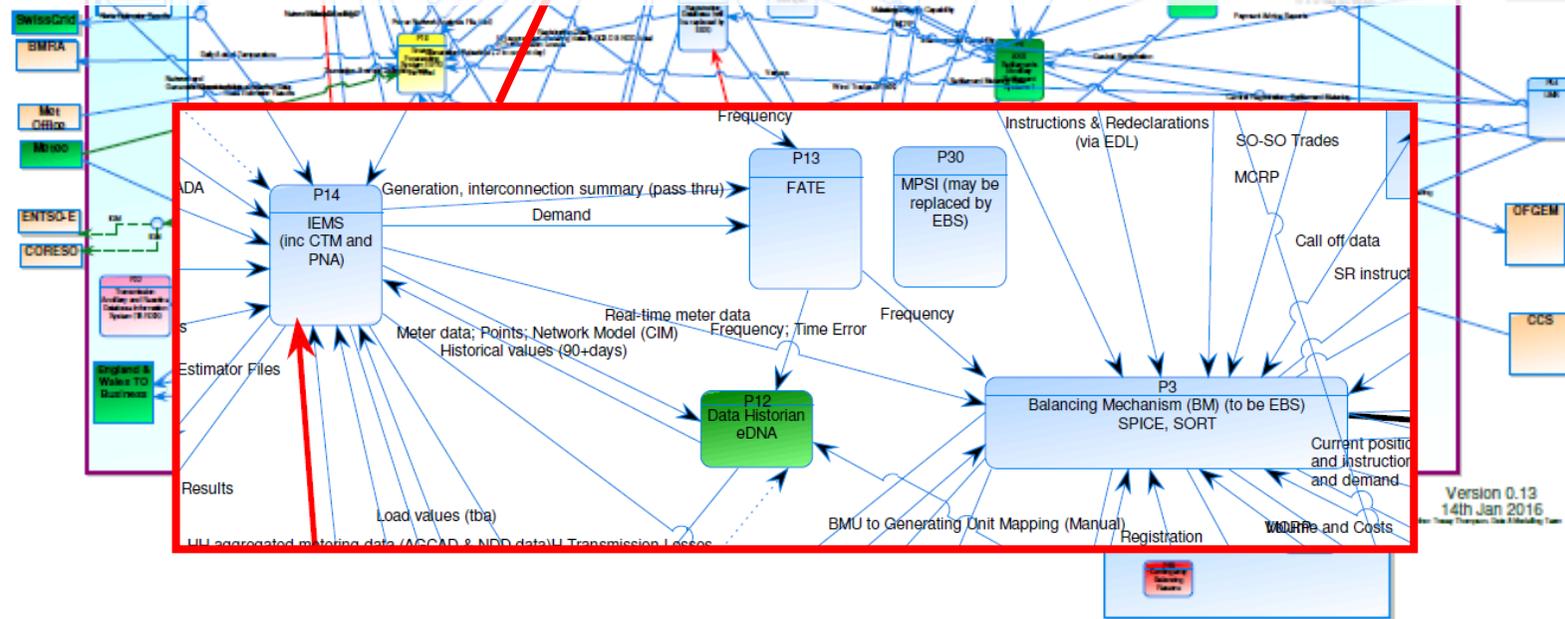
Bad data handling



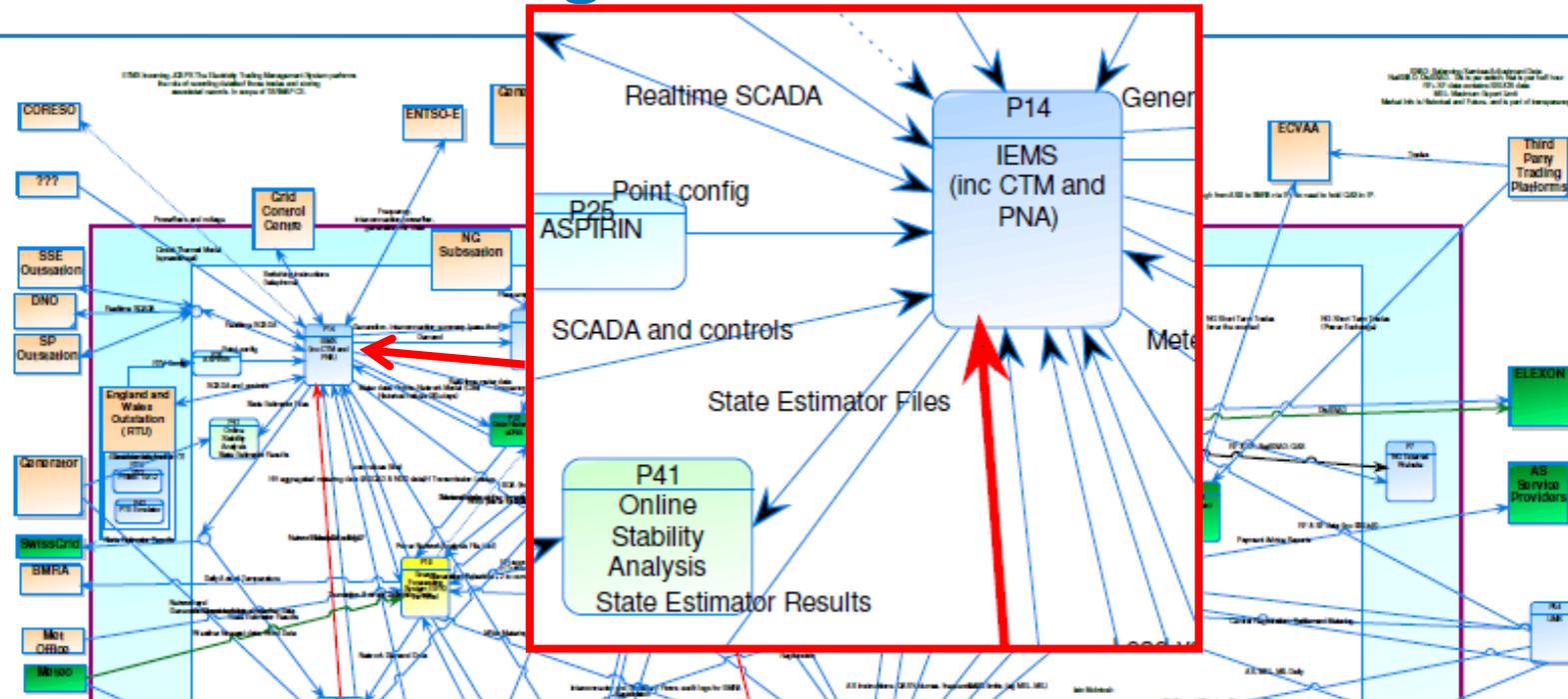
- “Error dumping, eg on generator auxiliary loads or The Great West Weybridge Circulation
 - Ok for a loadflow, but doesn’t work in a stability program!
 - Now solved by a fix from GE
- Hand dressing delays/errors for switch states or manual over-ride of bad data
 - DNO network without metering; wind farms with zero or reversed metering
- Generators solving just above Pmax; problems for the stability program.

No system is designed to be a master repository

- Legacy situation: each system just holds its own data
 - Often with its own naming convention and modelling approach.
- We are using the IEMS as a master in some respects
 - 50,000 data points added for new balancing system model (EBS)
 - EBS needs to know about small generators that IEMS doesn't care about
 - CIM transfer was harder than we expected!
- Enterprise Service Bus being deployed

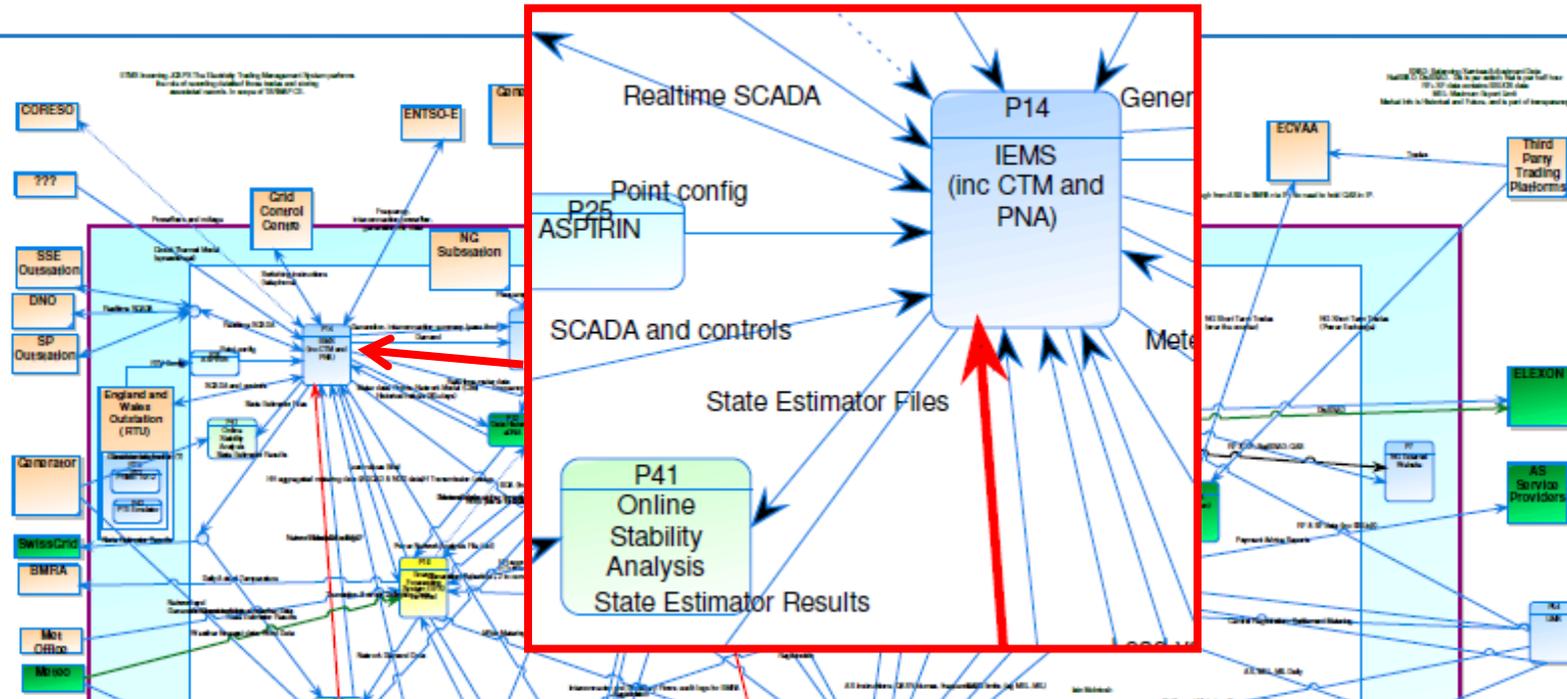


Various modelling issues



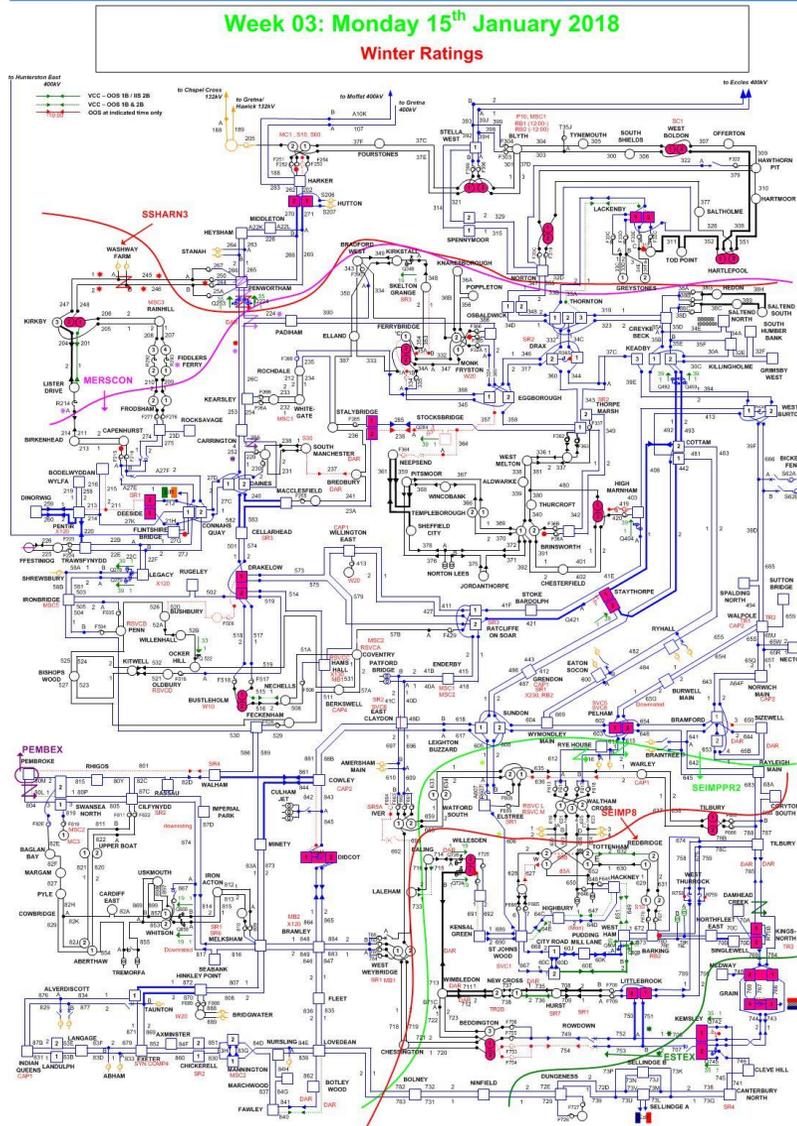
- Mutual impedances; very hard to import from the off-line analysis suite
- SVCs: metering is at LV, but the model is at the HV.
 - The slope correction has proved problematic...
- Intertrips that create islands can be troublesome
- The Voltage-Dependent Load Model in OSA doesn't work well for high voltages

Process issues



- The contingency list includes multiple versions of faults, for example with and without intertrips or reactor switching.
- This helps the control engineers decide which intertrips to arm etc.
- But if you just export the contingency list into an optimiser, it will try to secure the most onerous version of the fault, even if that is not the prevailing condition.

The problem itself isn't straightforward...



Pre-fault

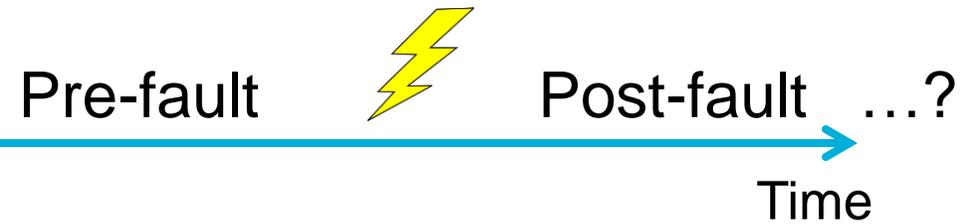
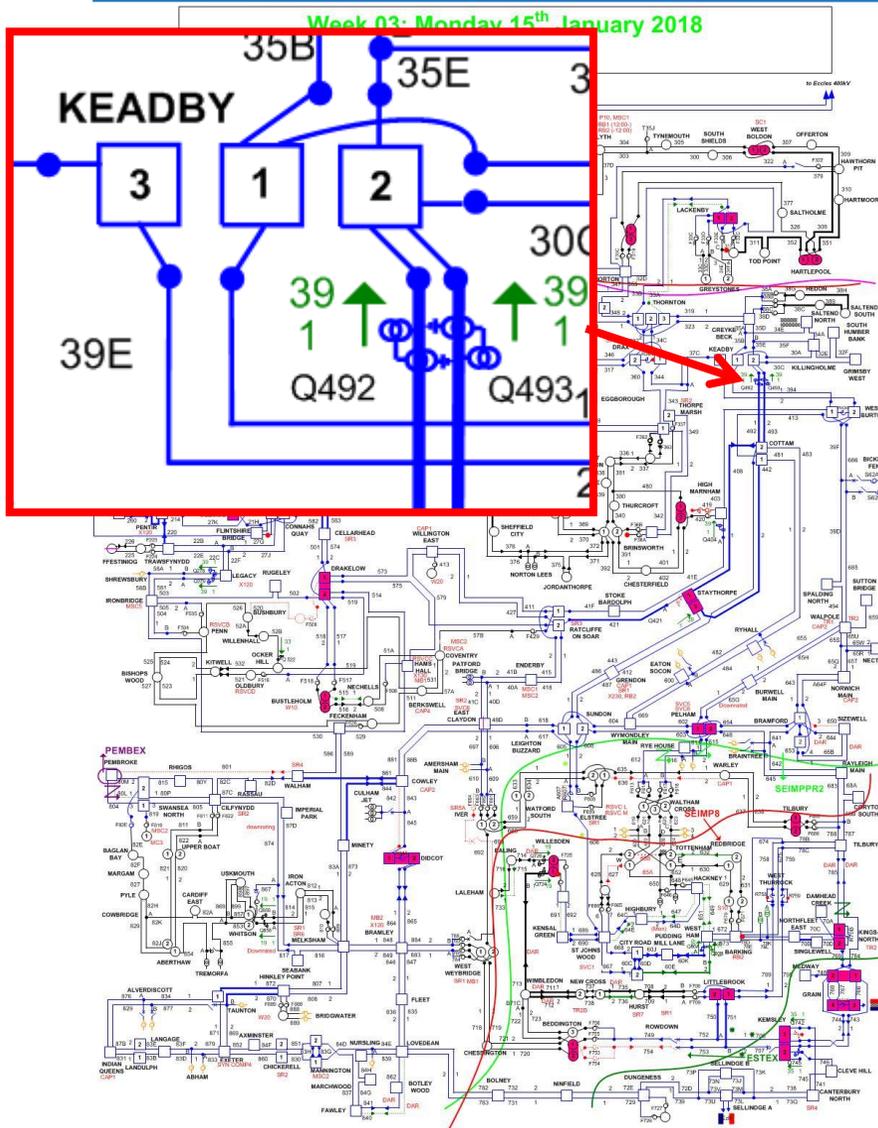


Post-fault ...?

Time

- When does “post-fault” become “pre-fault” again? How long do I have before the system must be re-secured?
- If you run an optimiser immediately after a fault, it will try to secure the system again straight away, which is equivalent to securing the system to N-D-D or N-1-1.

The problem itself isn't straightforward...



- If the fault wasn't the critical fault, can I use my post-fault ratings?
- If I implement local automatic control of QB tap position, how does the QB controller know that a fault has occurred? (reliably?)
- If you get it wrong, automatic control could make the problem worse.
- This is why we still use manual control for QBs...

The people factor...

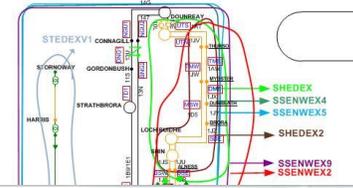
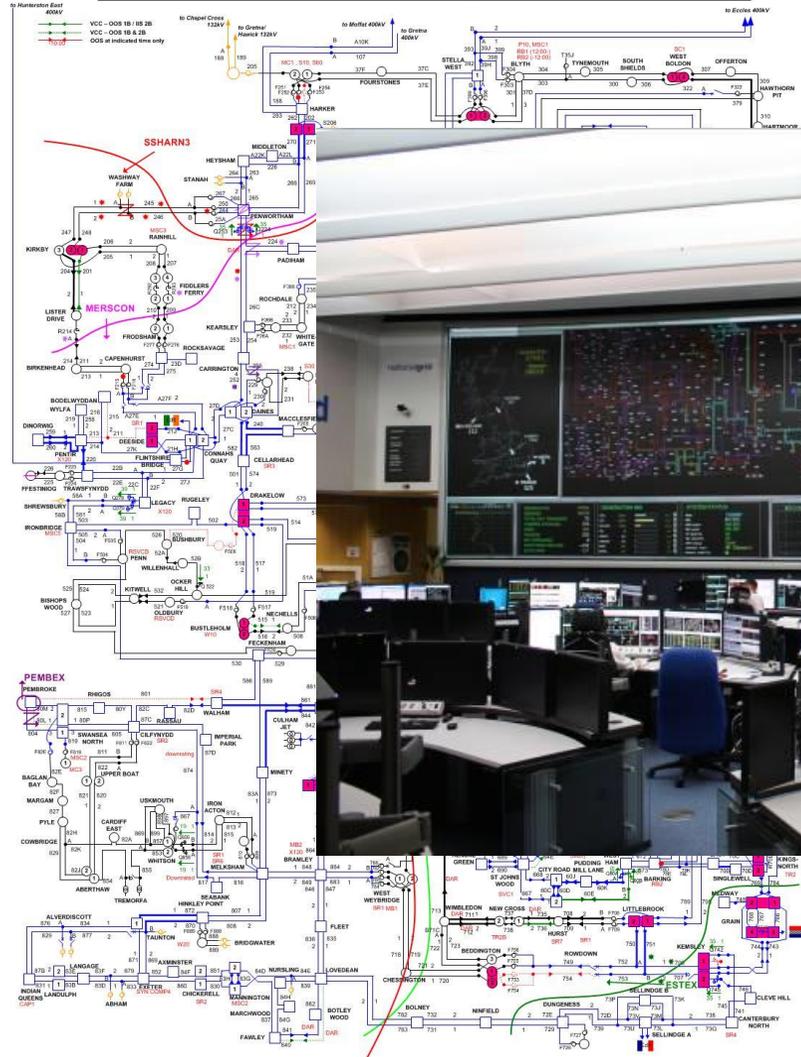
- Does it tell me something I don't already know?
- Is it easy to use?
- Does it explain why it's done what it's done?
- In terms I can understand?
- Can I trust it?
- Is it quick?
- Is it always available?
- Is the advice usable?
- Is the advice stable?
 - I don't want a different answer every five minutes...

User confidence is essential.

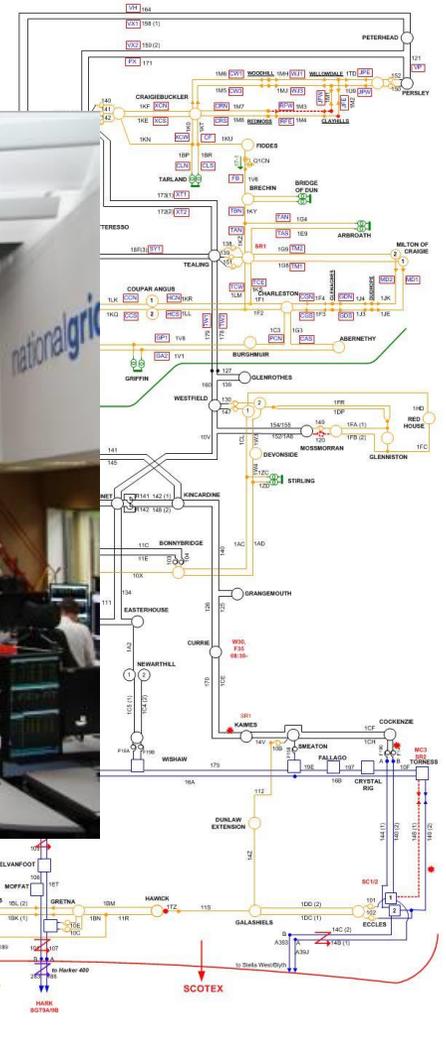


Time is a constrained commodity...

Week 03: Monday 15th January 2018
Winter Ratings



Week 03: Tuesday 16th January
Winter Ratings for SHETL, SP Cables and OHLs



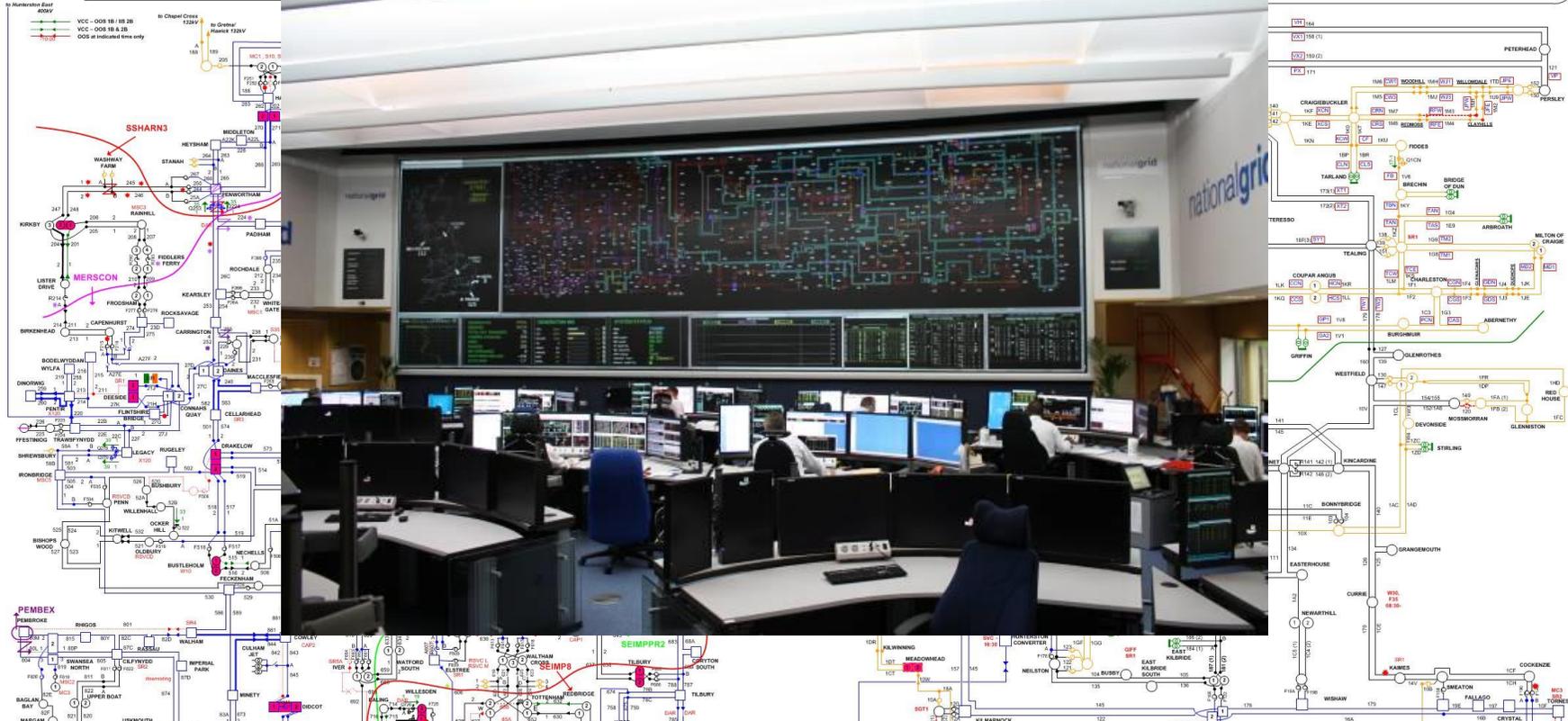
Master: Last updated 18/04/17

But the good news is...

Week 03: Monday 15th January 2018

Week 03: Tuesday 16th January

Outages for SHETL, SP Cables and OHLs



... after years of chipping away at the problems, and with a full-time person monitoring and tuning the State Estimator, its availability is >99%. (And OSA is pretty reliable too 😊)