RDS in Bane NOR

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NIM NES RDS WG 2024-06-04

SN/K 381 2024-06-06

Content

- RDS for power networks
- Example of RDS utilisation
- RDS in Bane NOR

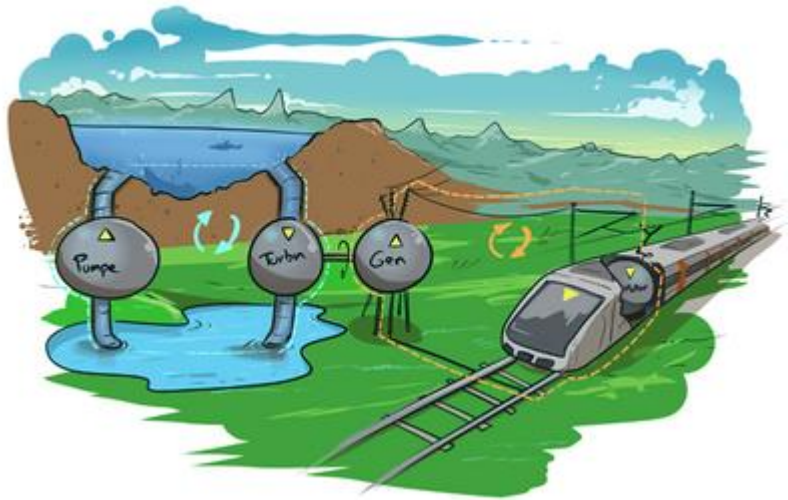
RDS for power supply networks

Content

- What is power supply networks?
- Proposed standardisation hierarchy
- Proposed main system classes
- Proposed structuring rules
- Examples
- Still open points

RDS for power supply networks

- Power supply networks are
  - Substations
  - Power lines
- Power supply networks are
  - Transmission supply network
  - Distribution supply network
  - Traction supply network
  - …



- Bane NOR motivation – we have
  - Distribution supply networks (3~ 22 or 11 kV 50 Hz, 2~ 55 kV 16 2/3 Hz)
  - Traction supply networks (1~ 15 kV 16 2/3 Hz, 2~ 30 kV 16 2/3 Hz, converter substations, transformer substations)

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RDS for power supply networks – Proposed standardisation

- ISO/IEC 81346-1/2 **Industrial systems** – Basic rules/Classification codes
  - ISO/IEC 81346-10 **Power supply systems** – Principles
    - ISO/IEC 81346-101 **Power plants** – Modelling concepts and guidelines
      - ISO/IEC 81346-105 **Power supply networks*** – Guidelines
        - ISO/IEC 81346-10? **Add-on for traction** power supply networks

- Railway should only be specified as an add-on to general power networks for it's peculiarities:
  - Sectioning of lines due to need for continuous contact and power transfer to the moving trains
  - Current path in running rail (return circuit)
  - Higher requirements and therefore more products for static and dynamic behaviour
  - …

(* Power supply networks = power grids. Anyway; an idea for a new «REN-blad»?)

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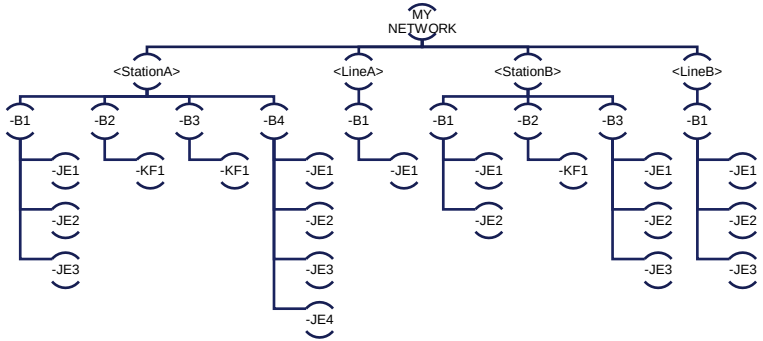
RDS for power supply networks – Proposed main system classes

	Treatment systems	Controlling systems	Conducting systems	Storing systems
Power supply system	A (new use)	B (new definiton)	J (new)	E (no change)
Technical systems	KF, (RA)	KL	JE, (A?)	QD
Component systems	TA?, TB?, RB?, GA?, MAA	QA?, QB?, QC?, QZ?, (UAA)	WB?, WD?, WE? (XB?, XD?) XE?	CCA

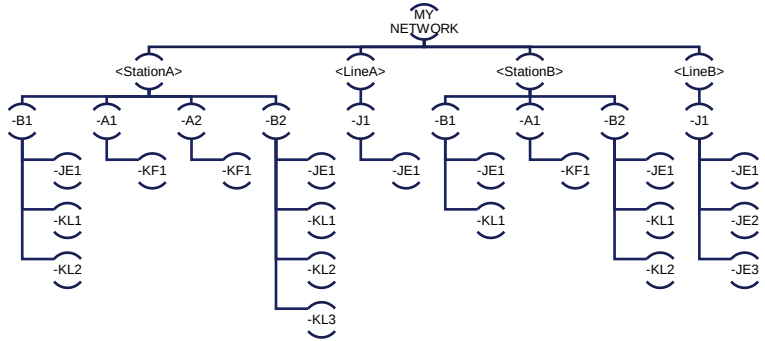
- Reason: Better overview is gained by distinction between
  - A Treatment systems as converters, transformers etc.
  - B Controlling systems as switchgear etc.
  - J Conduction systems as lines etc.

  without the need to use %Type

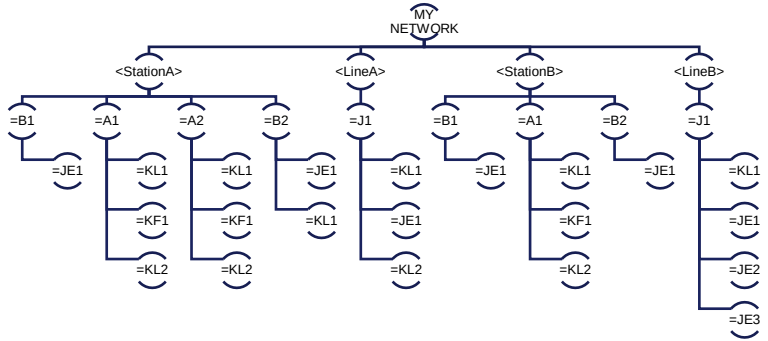
-Product today



-Product proposal



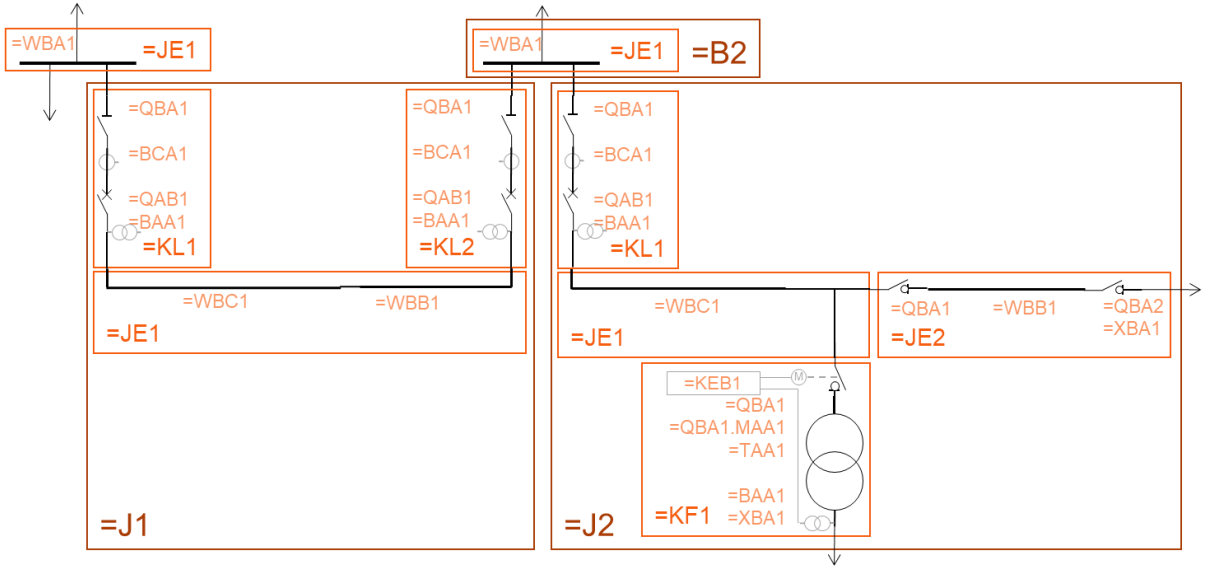
=Function proposal

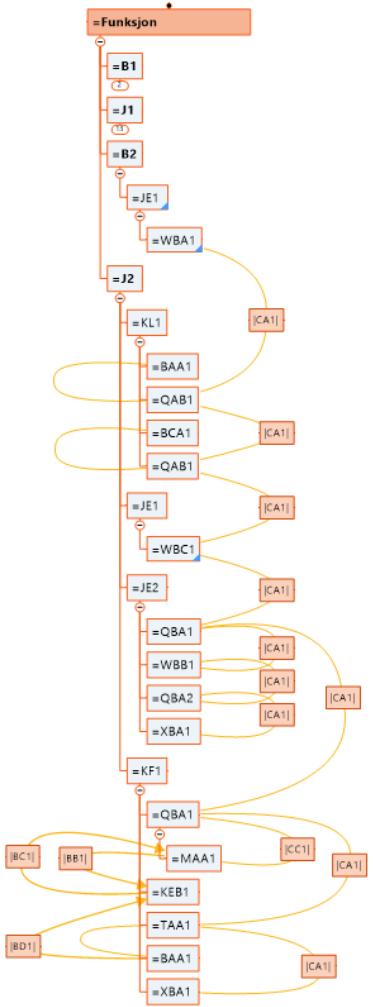


RDS for power supply networks - Aspects

- Function aspect and product aspect are really different
  - Both are important
- Power network’s function is to transport electric energy
  - Related to operation/service without considering technical solutions
- Power network’s assembly is its physical realisation
  - Related to specific solutions
- Need for different type aspects?
  - Function aspect -> Type of function (E.g. protection +BUB1 %BUB2 (Distance protection))
  - Product aspect -> Type of product (E.g., protection –BUB1 %BUB1 (ABB REL517))

Relations in +Function





Creates a «digital twin of the system»!

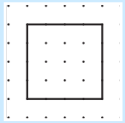
RDS for power supply networks – Proposed structuring rules

Main systems separated by circuit breakers (QAB)

Or normally OPEN (load) disconnectors for ABNORMAL feeding conditions

Technical systems separeted by (load) disconnectors (QBA)

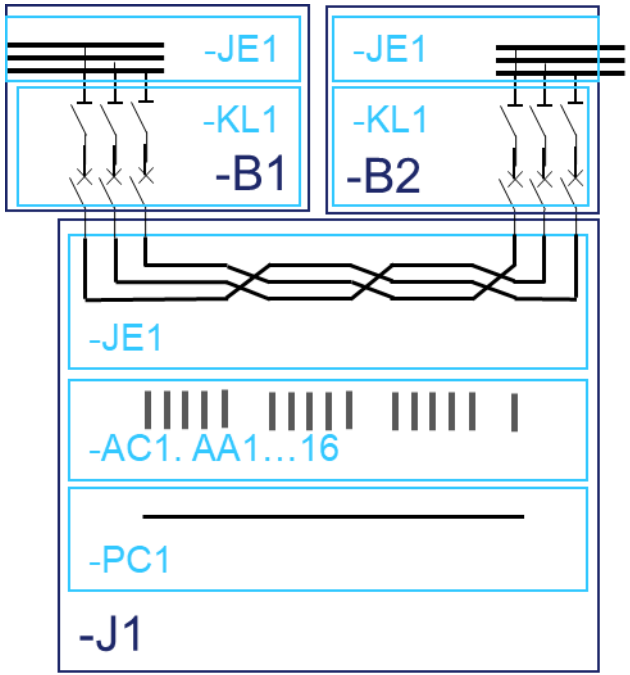
(normally CLOSED)

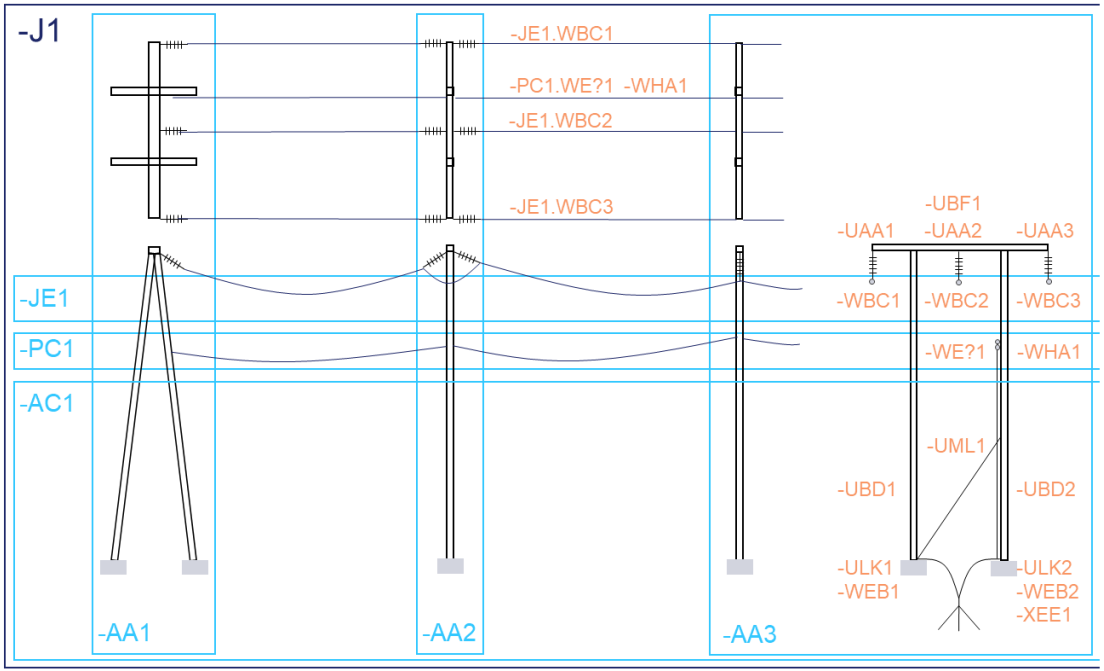


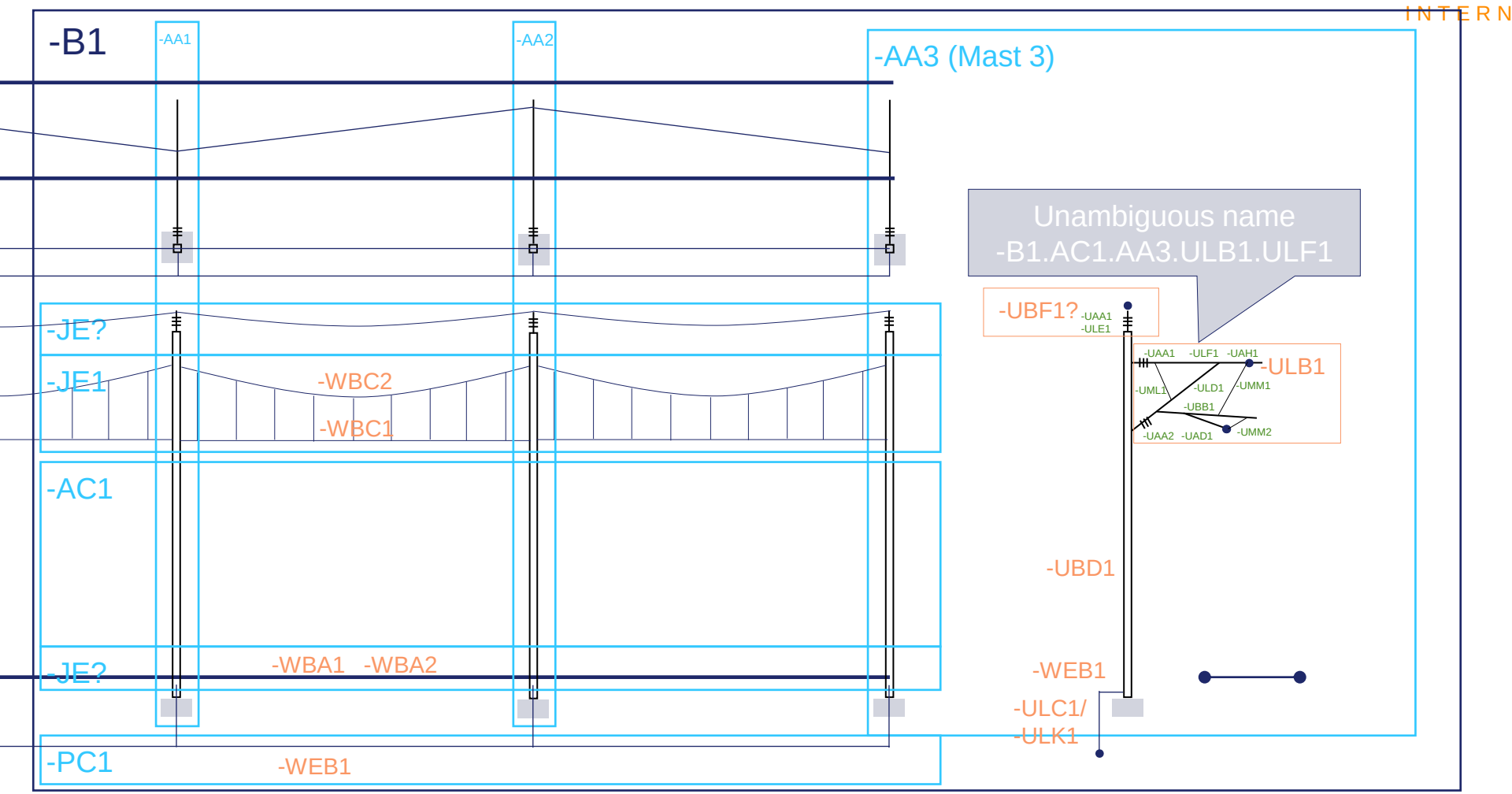
Composed technical controlling systems: KL (e.g. bays)

Otherwise single QAB or QBA as part of other technical systems, e.g. JE

RDS for power supply networks – Example product designation






-B1
-AA1
-AA2
-AA3 (Mast 3)
Unambiguous name
-B1.AC1.AA3.ULB1.ULF1
-UBF1?
-UAA1
-ULE1
-UAA1
-ULF1
-UAH1
-ULB1
-UML1
-ULD1
-UMM1
-UBB1
-UAA2
-UAD1
-UMM2
-JE?
-JE1
-WBC2
-WBC1
-AC1
-UBD1
-JE?
-WBA1
-WBA2
-WEB1
-ULC1/
-ULK1
-PC1
-WEB1

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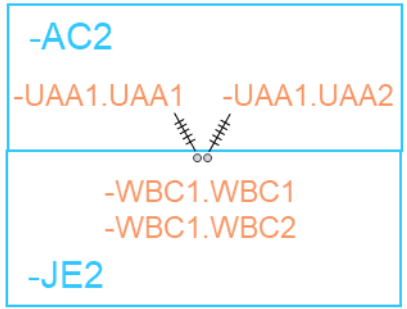
RDS for power supply networks – Still open points

- Use of top nodes
  - Each network one common node?
  - Each substation and line a separate node?
- Need for separate Type aspects related to function and product aspects?
- Efficient structure in product aspect for lines
- Site location aspect
- Distinction between phases, specially when there are several parallel components per phase
- Process control
- Some need for more component systems in Part 2
- Accept for the proposed J-system and changed definition of A and B.
- +…



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Example of RDS utilisation

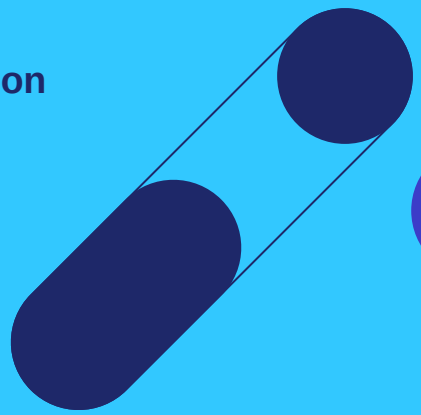
Presentation of student project at NTNU:

«**Automated Railway Single-Line Diagram Generation Using RDS (ISO/IEC 81346)**»

Hellebust, Haakon

Klevan, Sondre

Salihzada, Nima



Task: Examples of RDS utilisation in traction power supply systems

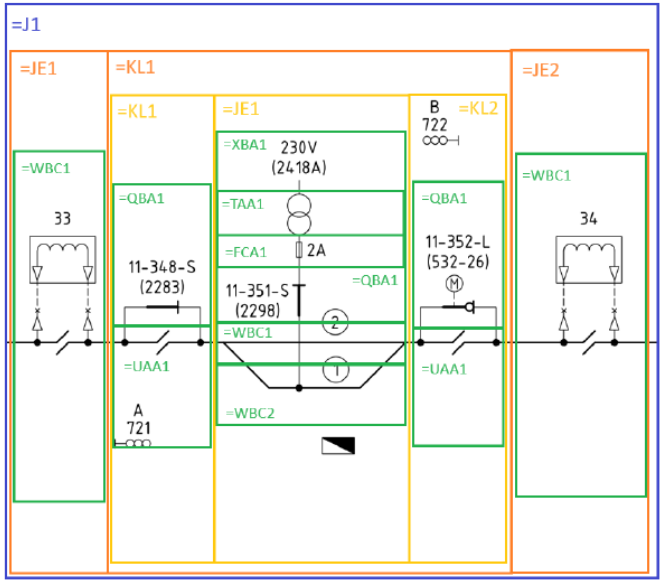
1. Describe a traction power supply system by RDS
2. Establish a relation database containing the RDS model
3. Show how RDS model can be utilized, e.g., visualised

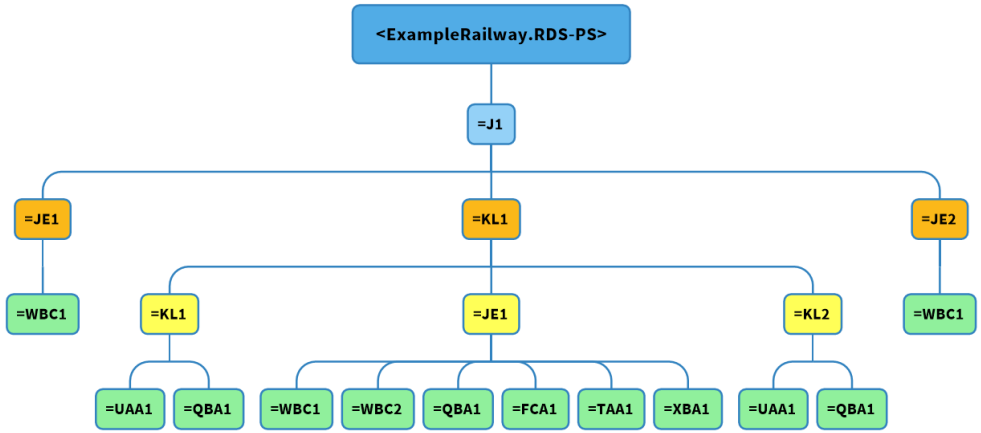
Chosen approach: Automatically draw a single-line diagram

INTERN

1. Describe a traction power supply system by RDS

- Different structuring principles in function aspect were considered to
  - follow guidelines
  - give good overview





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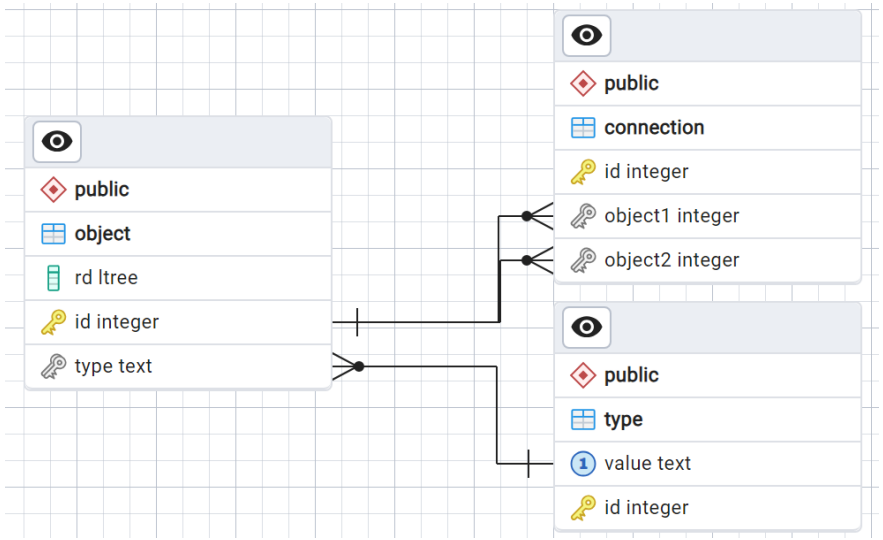
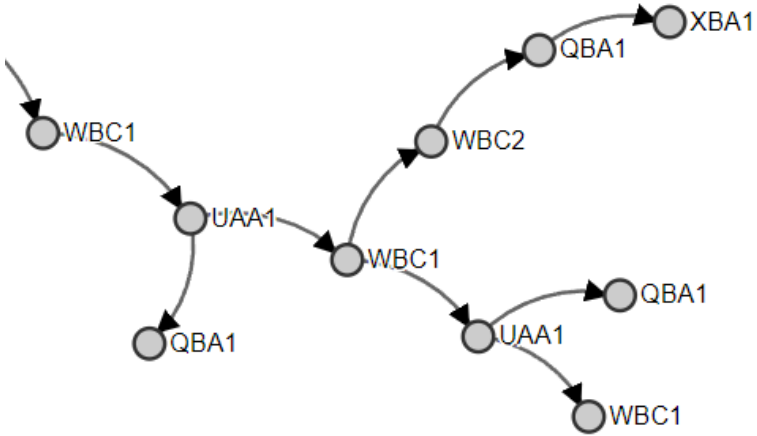
2. Establish a relation database containing the RDS model

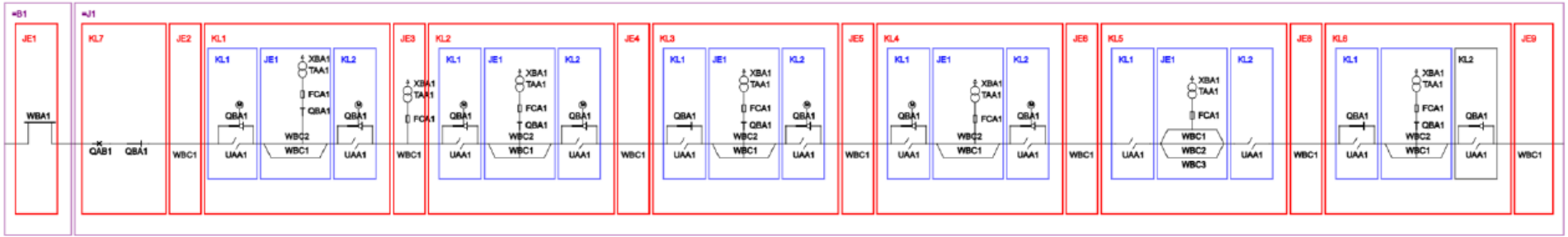
- Implemented function and type aspect with relations
- Database visualized by connection graphs





3. Show how RDS model can be utilized, e.g., visualised

- Automatically draw single-line diagram based on the database
- Example: Dovrebanen from Lundamo towards Heimdal (and Trondheim)



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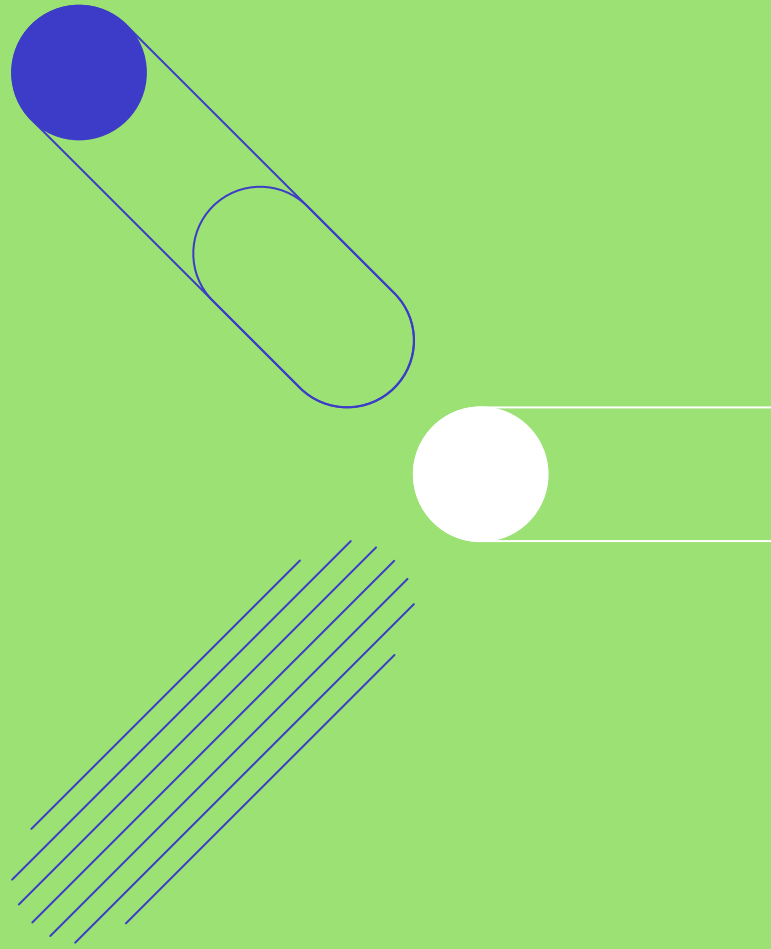
Conclusion

- By describing the traction power supply system by
  - Function aspect
  - Elektrical relations
  - Type aspect

  it is possible to draw up a single line diagam.
- The diagram may be easiliy updated by a change in the database description.

INTERN

RDS in Bane NOR



Requirement on reference designation (2019)

ID	TRV:00330
Bok	510
Kapittel	4
Vedlegg	
Kravtype	
Kravtekst	b) **Anleggsmerking:** Referansesystem for anleggsmerking skal følge anerkjente standarder, fortrinnsvis IEC 81346-serien.
Grafikkvisning	
Krav følger av	
Kravhensikt	
Endringsartikler	510 2019 Endringsartikkel 2349
Relatert krav	
Opprettet	2019/09/09
Referanse	
Status	Gjeldende
Banedataobjekt	
Kravlokasjon	Kravlokasjon

Asset structure (2022)

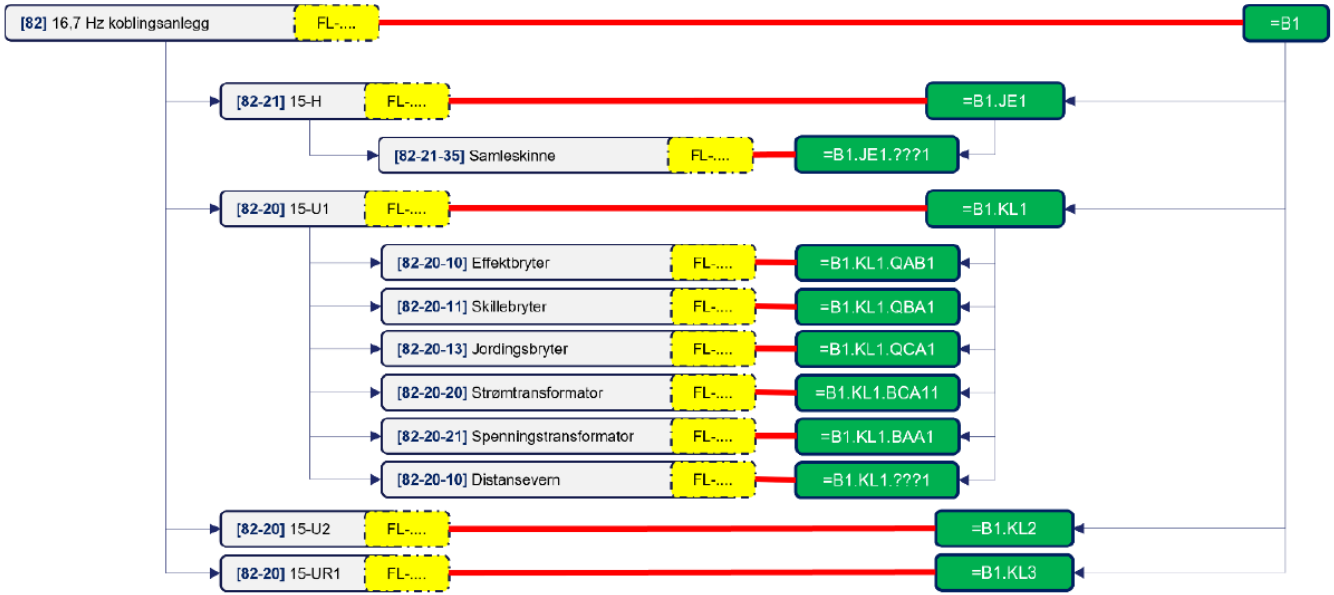
- Request for Company asset structure
- Power supply experts used hierarchical structure based on product aspect (RDS methodology used)
- (Company rules, RDS tags until further hidden)

STY-605512 Kodeliste for systemnedbrytningsstruktur - veiledning, Rev.000

Nivå 0	Nivå	Hovedsystem	Nivå	Systemtype	Lang beskrivelse	Nivå	Funksjonstype	Lang beskrivelse
Elkraftforsyning til tog 30-39	31	Ledningsanlegg	31-00	Ledningsanlegg generelt		31-00-01	Skilt elektro for kjørende personell	
			31-01	Kontaktledningsanlegg generelt	Kontaktledningsanlegg og kraftledningsanlegg (omfatter alle elutforminger)			
			31-02	Kraftledningsanlegg generelt				
			31-10	Kontaktledning	(Dummy til 31-11 eller -12 er bestemt)			
			31-11	Kontaktledning (innspent)	Kontakttråd, bæreline, hengetråder, y-liner, avsprenninger (lodd-, fast-, fix-,	31-11-01	Kontaktledning	
						31-11-02	Avspenning kontaktledning	
			31-12	Kontaktledning (strømskinne)	Kontakttråd, diltasjonskjøter, profilholder for kontakttråd, transaksjonsstykker	31-12-01	Strømskinne kontaktledning	
			31-13	Seksjonering	Seksjonsfelt (uisolert), seksjonsisolator, (nøytralseksjon - vi må diskutere hvordan håndtere et slikt	31-13-01	Seksjonsisolator	
						31-13-02	Nøytralseksjon	
						31-13-03	Seksjonsfelt	
			31-20	Kraftledning	(Dummy til 32-11 eller -12 er bestemt)			
			31-21	Kraftledning (luftline)	Faseledere (tau), avspenning	31-21-01	Tau	AT(PL/NL)-, fjern-, forbigang-, forsterkning-, mateledning for
						31-21-02	Avspenning kraftledning	
			31-22	Kraftledning (kabel)	Faseledere (kabler), skjøter, endeavslutninger, overspenningsvern	31-22-01	Kabel	AT(PL/NL)-, fjern-, forbigang-, forsterkning-, mateledning for kabel, inkl. komponent skjøt og endeavslutning.
						31-22-02	Overspenningsvern, kraftledning	
			31-30	Konstruksjoner for ledningsanlegg	Fundamenter, master, utliggere (inkl isolator), åk, barduner, strevere, traverser, konsoller	31-30-01	Mast for kontaktledning	Mast med fundament og bardun og evt. Utligger.
						31-30-02	Mast for kraftledning	Mast med fundament og evt. Bardun
						31-30-03	Åk	Åk med hengemaster.
			31-40	Føringsveier for ledningsanlegg	Kabelkanaler, kabelstiger/-bruer, kabelkummer, rørkryss, grøfter, stikkrenner	31-40-01	Kabelføring for ledningsanlegg	
			31-50	Returkrets	Returledere, filterimpedanser, sugetransformatorer, overkast, tverrforbindere, skinneforbindere	31-50-01	Returledning	
						31-50-02	Filterimpedans/PAK	
						31-50-03	Sugetransformator	
						31-50-04	Returkrets i spor	
			31-60	Bryteranlegg	Skillebryter, lastskillebryter, effektbryter, jordingsbryter, manøvermaskin, RTU, eventuelt vern, strømforsyning	31-60-01	Bryter for ledningsanlegg	
						31-60-02	Manøvermaskin	
						31-60-03	Vern for bryteranlegg	
						31-60-04	Understasjon/ RTU-ledningsanlegg	
			31-70	Autotransformatoranlegg for ledningsanlegg	Transformator med fundament inkl. oljeoppsamlingsløsning	31-70-01	Autotransformator	
			31-80	Beskyttelsessystem for ledningsanlegg	Avskjerming, gjerder, skilt, jording, utjevning, jordleder, klatrehinder, kiosk (svært enkelt konstruksjon uten fasiliteter), eventuelt overspenningsvern	31-80-01	Avskjerming til bru	
						31-80-02	Jordleder/-nett, ledningsanlegg	
						31-80-03	Jordelektrode, ledningsanlegg	
						31-80-04	Jordigsskinne, ledningsanlegg	
						31-80-05	Overspenningsvern, ledningsanlegg	
						31-80-06	Utjevningsforbindelse, ledningsanlegg	

Substations 16 2/3 Hz (2023)

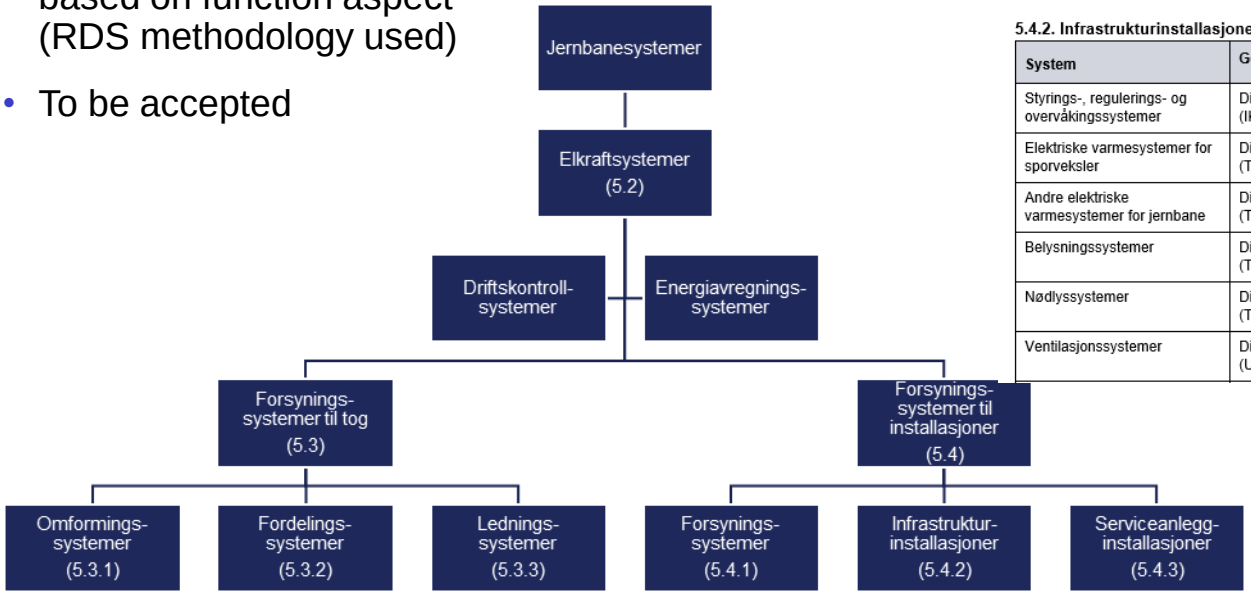
- Expect suppliers to follow RDS in future
- Made mapping to Bane NOR today's proprietary system
- Free text field in asset database for RDS-tag available



BANE NOR

System responsibility (2024)

- Request for company management procedure
- Proposed hierarchical structure based on function aspect (RDS methodology used)
- To be accepted



5.4.1. Forsyningssystemer

System	Generisk systemansvarlig	Spesifikk systemansvarlig	RDS-PS
Fordelingssystemer	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner, Energi)	=B1
Ledningssystemer	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	=J1
Forsyningssystemer fra stedlig netteier	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	= ?

5.4.2. Infrastrukturinstallasjoner

System	Generisk systemansvarlig	Spesifikk systemansvarlig	RDS-CW
Styrings-, regulerings- og overvåkingssystemer	Digitalisering og teknologi (IKT)	Drift og vedlikehold (Regioner)	=L1.LC1
Elektriske varmesystemer for sporveksler	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	=H1
Andre elektriske varmesystemer for jernbane	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	=H2
Belysningssystemer	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	=Q1
Nødlyssystemer	Digitalisering og teknologi (Teknisk)	Drift og vedlikehold (Regioner)	=P1
Ventilasjonssystemer	Digitalisering og teknologi (Underbygning)	Drift og vedlikehold (Regioner)	=J1

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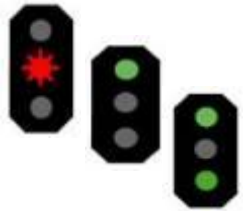
Along-track signal register (2024)

- Request for unique and permanent register over along track signal lamps and signs
- Power supply experts proposed structure based on type aspect (RDS methodology used)
- To be tested and accepted

```
<Bane NOR.RDS>
%PFA1 (Innkjørhovedsignal)
        %PFA1.PFA1 (Signal 20A «Stopp»)
        %PFA1.PFA2 (Signal 21 «Kjør med redusert hastighet»)
        %PFA1.PFA3 (Signal 22 «Kjør»)
%PFA2 (Utkjørhovedsignal)
        %PFA2.PFA1 (Signal 20B «Stopp»)
        %PFA2.PFA2 (Signal 21 «Kjør med redusert hastighet»)
        %PFA2.PFA3 (Signal 22 «Kjør»)
%PFA3 (Indre hovedsignal)
        %PFA3.PFA1 (Signal 20B «Stopp»)
        %PFA3.PFA2 (Signal 21 «Kjør med redusert hastighet»)
        %PFA3.PFA3 (Signal 22 «Kjør»)
%PFA4 (Blokksignal)
        %PFA4.PFA1 (Signal 20A «Stopp»)
        %PFA4.PFA3 (Signal 22 «Kjør»)
%PFA5 (Forsignal hovedsignal)
        %PFA5.PFA1 (Signal 23 «Forvent stopp»)
        %PFA5.PFA2 (Signal 24 «Forvent kjør med redusert hastighet»)
        %PFA5.PFA3 (Signal 25 «forvent kjør»)

%PHD1 (Markerboard E35)
```



Remote control signalling names (2024-2025)

- Request for list of all required remote control signalling names
- Power supply experts naming based on function aspect (RDS and IEC 61850 methodology used
- To be tested and accepted

	AD	AE	AF	AG	AH	AI
1	Fremtiden					
2	Objektreferanse iht. IEC 81346-10 (TRV:00330) (eksempel) 81346-10 Tabell B.1, 81346-10 Tabell B.2, 81346-2- Tabell 3	Logisk node iht. IEC 61850-7-4 (TRV:08180)	Dataobjekt iht. IEC 61850-7-4 (TRV:08180)	Dataattributt iht. IEC 61850-7-3/4 (TRV:08180)	Objektbeskrivelse engelsk	Signalbeskrivelse engelsk
3	<.RDS-PS>=B2.JE1.BAA1	TVTR	VolSv	instMag	16-Hz main busbar	Voltage measurement
4	<.RDS-PS>=B2.JE1.F??1	PTUV	Str	general	16-Hz main busbar	Undervoltage protection pickup
5	<.RDS-PS>=B2.JE1.F??1	PTUV	Op	general	16-Hz main busbar	Undervoltage protection trip
6						
7	<.RDS-PS>=B2.JE1.F??1	PTUV	Op	general	16-Hz main busbar	Undervoltage protection trip
8						
9						
10						
11	<.RDS-PS>=B2.KL1.F??1	PDIS1	Op	general	16-Hz feeder line	Distance protection (comb/quad) zone 1 trip
12	<.RDS-PS>=B2.KL1.F??1	PDIS2	Op	general	16-Hz feeder line	Distance protection (comb/quad) zone 2 trip ZK
13	<.RDS-PS>=B2.KL1.F??1	PDIS2	Str	general	16-Hz feeder line	Distance protection (comb/quad) zone 2 pickup ZK
14	<.RDS-PS>=B2.KL1.F??1	PDIS3	Op	general	16-Hz feeder line	Distance protection (comb/quad) zone 3 trip ZK
15	<.RDS-PS>=B2.KL1.F??1	PDIS3	Str	general	16-Hz feeder line	Distance protection (comb/quad) zone 3 pickup ZK
16	<.RDS-PS>=B2.KL1.F??1	PDIS4	Op	general	16-Hz feeder line	Distance protection (comb/quad) zone 2 trip (load)
17	<.RDS-PS>=B2.KL1.F??1	PDIS4	Str	general	16-Hz feeder line	Distance protection (comb/quad) zone 2 pickup (load)
18	<.RDS-PS>=B2.KL1.F??1	PDIS5	Op	general	16-Hz feeder line	Distance protection (comb/quad) zone 3 trip (load)
19	<.RDS-PS>=B2.KL1.F??1	PDIS5	Str	general	16-Hz feeder line	Distance protection (comb/quad) zone 3 pickup (load)

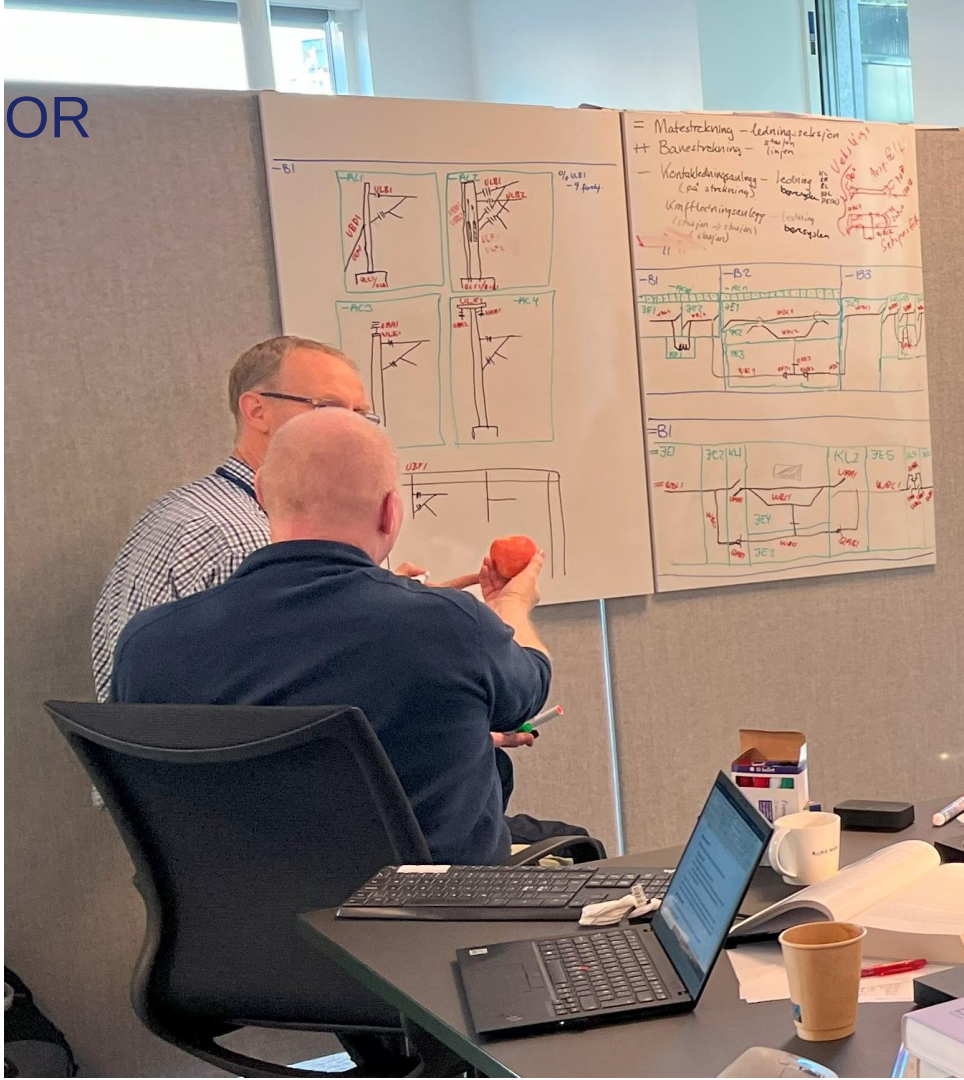
INTERN

Summary use of RDS in Bane NOR

- No Company decision taken
- Local Power supply initiative
- Developing RDS proposal for guidelines for traction power supply networks
- Power supply experts use RDS methodology when possible

Experience

- **Systems thinking is very powerful!**
  - RDS is a clear protocol to communicate
  - RDS is a pedagogical tool to explain “the world”
  - Integrates well with risk assessment and asset management



BANE NOR

Vi forbedrer og moderniserer
for at flere kan ta mer tog