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Establishing Sufficient Redundancy: Protection & Telecommunication

August 2007



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Australian National Electricity Rules

- S5.1.2 Network reliability
 - S5.1.2.1 Credible contingency events
 - (d) *The Network Service Provider must ensure that all protection systems for lines at a voltage above 66 kV, including associated intertripping, are well maintained so as to be available at all times other than for short periods (not greater than eight hours) while the maintenance of a protection system is being carried out.*

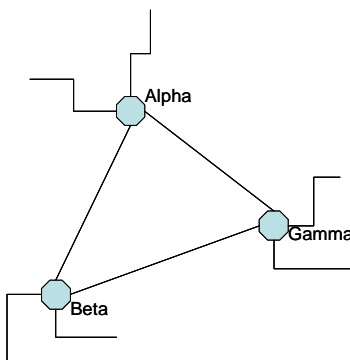
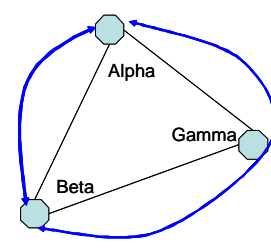
- S5.1.9 Protection systems and fault clearance times
 - Network Users
 - (d) *...the primary protection system must have sufficient redundancy to ensure that it can clear short circuit faults of any fault type within the relevant fault clearance time with any single protection element (including any communications facility upon which the protection system depends) out of service*



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Generic System

Alpha-Beta line needs 2 separate telecom links







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Choice of Bearer

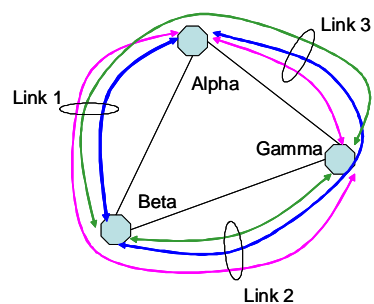
Technology	Copper pilots	Power Line Carrier	Radio	Fibre optic
Benefit	✓	✓	✓ ✓	✓ ✓ ✓
Main risks	✗ ✗ ✗ ✗	✗ ✗ ✗	✗	✗ ✗
Response time	✗ ✗ ✗ ✗	✗	✗ ✗	✗ ✗


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Basic Telecoms for 3 Lines

3 links each carrying 3 channels
 2 telecom links at each substation
 Maximum risk profile – failure of any one link will jeopardise all three lines



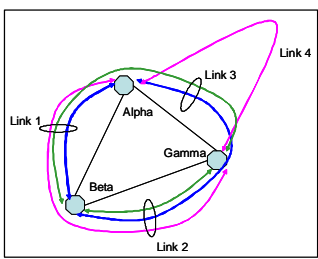
Link Failure	Alpha-Beta	Beta-Gamma	Alpha-Gamma
1	Yes	Yes	Yes
2	Yes	Yes	Yes
3	Yes	Yes	Yes


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First order mitigation

4 links dedicated link Alpha - Gamma
 Failure of Links 1 and 2 still jeopardises all 3 lines
 Failure of Link 3 affects 2 lines
 Failure of Link 4 affects only 1 line



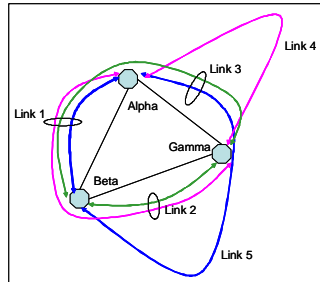
Link Failure	Alpha-Beta	Beta-Gamma	Alpha-Gamma
1	Yes	Yes	Yes
2	Yes	Yes	Yes
3	Yes	Yes	
4			Yes







Second order mitigation

5 links
 Extra Link 5 between Beta Gamma but still shared service via link 3
 Failure links 1, 2 and 3 still have significant risk profile



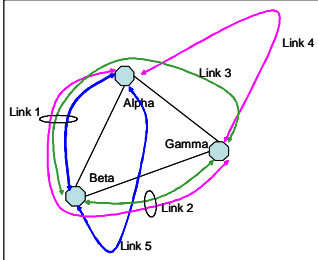
Link Failure	Alpha-Beta	Beta-Gamma	Alpha-Gamma
1	Yes	Yes	Yes
2	No	Yes	Yes
3	Yes	Yes	No
4	No	No	Yes
5	Yes	No	No







Third order mitigation

5 links – variation
 Second path Alpha - Beta eliminates common failure risk on Link 3
 Links 1 and 2 retain significant risk profile



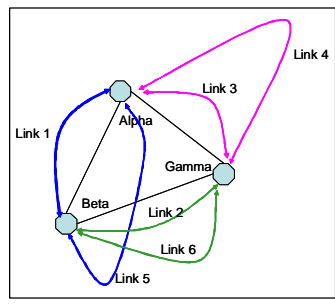
Link Failure	Alpha-Beta	Beta-Gamma	Alpha-Gamma
1	Yes	Yes	Yes
2	No	Yes	Yes
3	No	Yes	No
4	No	No	Yes
5	Yes	No	No


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Fourth order mitigation

6 links, 4 at each substation
 Each single service only
 Risk profile limited to directly related line only

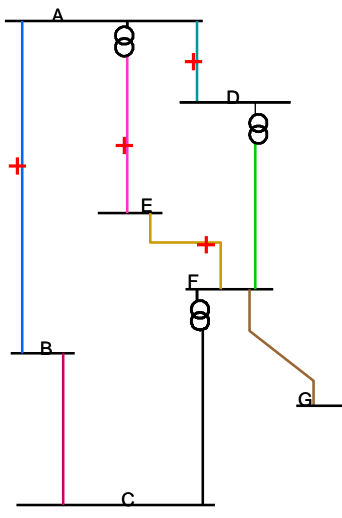


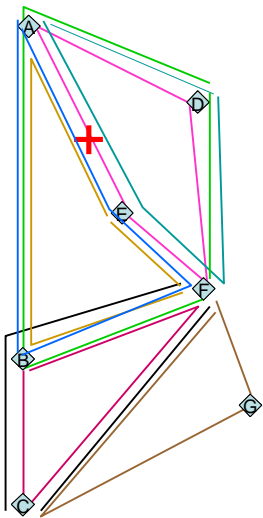
Link Failure	Alpha-Beta	Beta-Gamma	Alpha-Gamma
1	Yes		
2		Yes	
3			Yes
4			Yes
5	Yes		
6		Yes	

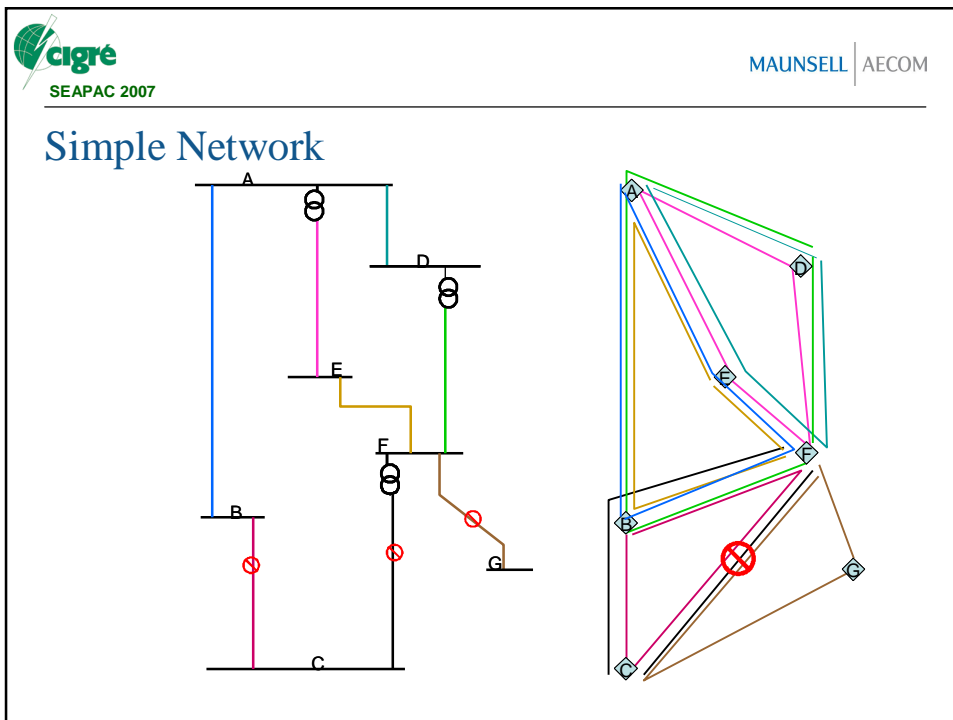
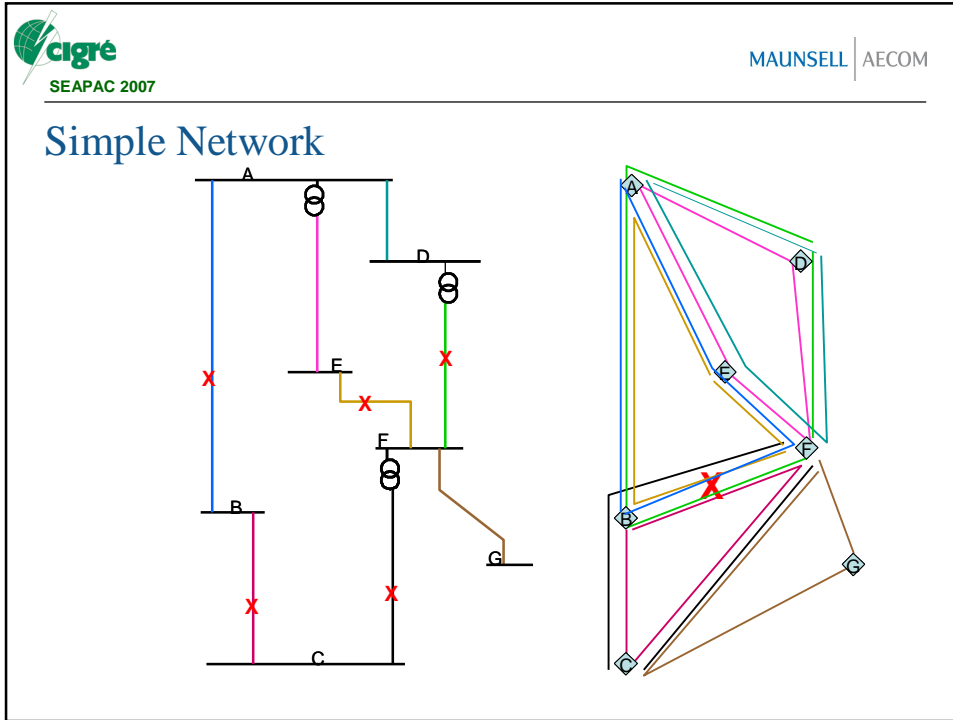

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Simple Network





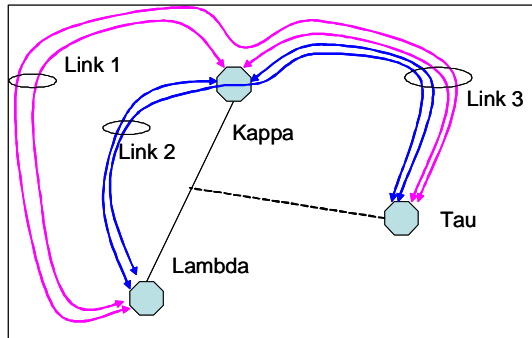



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Tee Network

X Protection – Blue
 Y Protection – Pink
 Simple Connection must consider CBF + Telecom failure implication
 Fundamentally not segregated

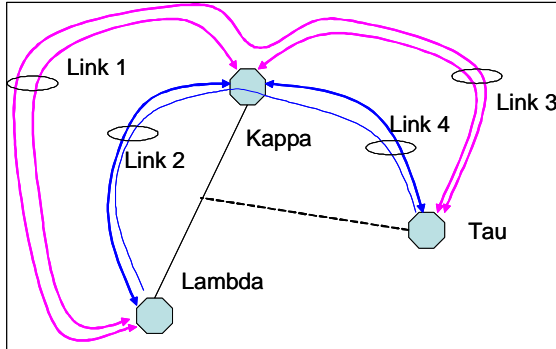



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Tee Network

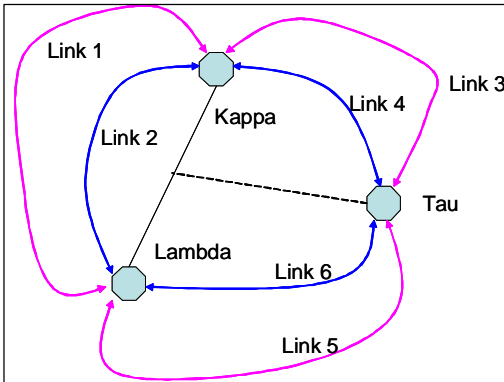
X Protection – Blue
 Y Protection – Pink
 Failure of any 1 of 4 links





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Tee Network

X Protection – Blue
 Y Protection – Pink
 Single failure has back up communication




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Conclusion

- ❖NER incorporates telecommunication systems in the definition of protection system
- ❖Power system operational constraints exist if only 1 operational telecom system
- ❖2 or more independent links cannot be assumed as meeting Rules or corporate requirements