

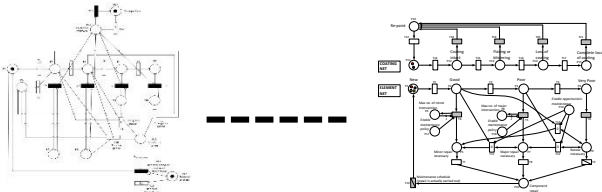
Background

How to select the optimal set of intervention strategies for each asset on a network to deliver the required level of service and safety for the minimum whole life costs?

Objective: Develop a 2-level approach

Asset level.

Models combining degradation/failure and intervention processes to explore the effects of a wide range of intervention strategies on the evolution of the asset state over time.



Input to

Network level optimisation.

Network-level optimisation model to support strategies selection subject to budget availability and performance targets.

Mathematical Programming to model the decisional process

$$\min f(X) = \sum_{e_i \in E} \sum_{s_j \in S} f_i \cdot n_{ij}^{SR} \cdot d_{ij}^{SR} \cdot x_{ij} \rightarrow \text{Minimise the impact on service}$$

Subject to:

$$1) \sum_{s_j \in S} x_{ij} = 1 \quad \forall e_i \in E \rightarrow \text{Select one strategy for each link}$$

$$2) \sum_{e_i \in E} \sum_{s_j \in S} c_{ij} \cdot x_{ij} \leq C \rightarrow \text{Total cost must be within budget}$$

$$3) \prod_{\forall i/e_i \in l_k} \left(\sum_{s_j \in S} a_{ij}^{LC} \cdot x_{ij} \right) \geq A_{l_k}^* \quad \forall l_k \in L \rightarrow \text{Threshold line availability}$$

$$4) x_{ij} \in \{0,1\}, \quad x_{ij} \begin{cases} 1 & \text{if strategy } s_j \text{ is applied to section } e_i \\ 0 & \text{otherwise} \end{cases}$$

Numerical example

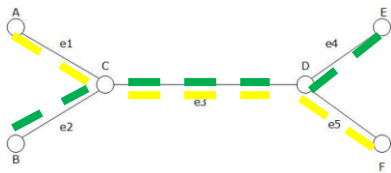


Table 1 Features of intervention strategies.

Strategy	n° of SR	Link Availability	Cost of strategy
S1	4.7	0.9	50-60
S2	3.8	0.95	70-80
S3	2.5	0.99	85-95

Table 3 Selected strategies.

Scenario	e1	e2	e3	e4	e5
1	S3	S3	S3	S3	S3
2	S3	S3	S3	S1	S3
3	S3	S1	S3	S3	S3
4	-	-	-	-	-
5	S3	S1	S3	S1	S3
6	S3	S1	S3	S1	S3
7	-	-	-	-	-
8	S3	S1	S3	S1	S3
9	-	-	-	-	-

Table 2 Scenario analysis results.

Scenario	Budget C	A _{l₁} [*]	A _{l₂} [*]	f(X)	A _{l₁}	A _{l₂}
1	470	0.95	0.85	12.5	0.97	0.97
2	430	0.95	0.85	14	0.96	0.90
3	410	0.95	0.85	15.32	0.97	0.86
4	390	0.95	0.85	-	-	-
5	410	0.95	0.80	15.31	0.97	0.86
6	390	0.95	0.80	15.31	0.97	0.86
7	370	0.95	0.80	-	-	-
8	410	0.92	0.85	15.32	0.97	0.86
9	390	0.92	0.85	-	-	-