

SUPPLEMENTAL MATERIALS

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Infrastructure Asset Management System Optimized Configuration: A Genetic Algorithm–Complex Network Theoretic Metamanagement Approach

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Appendix S2. Optimal Added Link Configurations

Table S1. Link additions according to the betweenness centrality (labels are defined in Figure 1).

| Link Additions | |
|----------------|---|
| 1 | S2,L3 |
| 2 | S2,L3 S3,R8 |
| 3 | S2,L3 S2,O3 S3,R8 |
| 4 | I4,L4 S2,L3 S2,O5 S3,R8 |
| 5 | I1,L3 S1,L3 S2,L4 S2,R8 S3,O5 |
| 6 | A3,O5 I1,L3 S2,L4 S2,O2 S2,R7 S3,L7 |
| 7 | I3,L4 I4,O5 R7,L4 S2,L3 S2,L8 S2,O3 S2,R8 |
| 8 | A3,R8 I3,O5 L2,O5 O2,L9 S2,L3 S2,L8 S2,O3 S3,A2 |
| 9 | A2,O3 I1,O2 I3,I1 S1,L9 S2,L4 S2,L8 S2,O1 S2,O3 S2,R8 |
| 10 | A2,O3 I1,O4 I2,L9 I4,L2 L2,O1 O2,L3 R7,L4 S1,L3 S2,R8 S3,O5 |
| 11 | I3,L3 L6,L4 O5,L9 R3,L5 R8,A2 S1,O3 S2,L3 S2,L6 S2,L7 S2,R8 S3,R7 |
| 12 | A4,O2 I1,O3 I2,R8 I3,L3 L2,O4 O5,L4 R8,A2 S1,R7 S2,L3 S2,L6 S2,L7 S3,O3 |
| 13 | A5,R8 I4,L3 L6,O5 O2,I0 O3,L7 O5,L9 R4,O4 R6,O4 R7,O3 S1,O1 S2,L7 S2,R8 S3,O5 |
| 14 | A3,O3 I1,R8 I2,R1 I4,O3 L1,O2 O4,L3 O5,L4 O5,L9 R2,L3 S1,R7 S2,A2 S2,O1 S2,O2 S3,L8 |
| 15 | A5,R8 I1,R7 I3,L3 I3,O5 L1,O3 L6,L1 O2,L1 O5,A2 R8,L6 S1,L3 S1,R2 S2,L4 S2,L8 S2,O1 S3,O2 |

Table S2. Link additions according to the closeness centrality (labels are defined in Figure 1).

| Link Additions | |
|----------------|---|
| 1 | S4,L11 |
| 2 | S4,L3 S4,L11 |
| 3 | S4,L3 S4,L10 S4,L11 |
| 4 | S4,L3 S4,L10 S4,L11 S4,R6 |
| 5 | S4,L3 S4,L10 S4,L11 S4,R5 S4,R6 |
| 6 | S3,R9 S4,L3 S4,L10 S4,L11 S4,R5 S4,R6 |
| 7 | L4,I1 S2,R9 S4,L3 S4,L10 S4,L11 S4,R5 S4,R6 |
| 8 | I3,O1 I3,R6 I4,L5 R2,R9 S4,L10 S4,L11 S4,O4 S4,R5 |
| 9 | I2,L5 I3,R5 I4,L10 R7,L11 S3,R9 S4,L3 S4,O3 S4,R6 S4,R7 |
| 10 | A5,L10 I2,L5 I3,R5 I3,R6 R7,L8 R7,L11 R7,O1 R7,O3 S3,R9 S4,R7 |
| 11 | I2,L10 I4,O1 O1,R9 R2,L3 R2,L5 R7,O1 R8,R5 S4,L11 S4,O3 S4,R2 S4,R6 |
| 12 | A2,L5 I1,L7 I1,L10 I2,R7 I3,O1 L7,R6 R7,R9 S4,I3 S4,L3 S4,L11 S4,O3 S4,R5 |
| 13 | I3,L5 I3,L7 I3,L11 I3,O4 I3,R2 I3,R6 I4,O1 O4,L4 R6,I2 S2,R9 S4,I3 S4,L10 S4,R5 |
| 14 | I3,L5 I4,L3 I4,O1 L1,R9 L11,R6 R2,L4 R2,L5 R2,R5 R7,I3 R7,L7 R7,L10 S4,L11 S4,O4 S4,R7 |
| 15 | A5,L11 I3,R7 I3,S4 L1,R9 L2,L5 R2,I3 R6,L1 R7,L3 R7,L7 R7,R5 R7,R6 S4,L4 S4,L10 S4,O5 S4,R7 |

Table S3. Link additions according to the eigenvector centrality (labels are defined in Figure 1).

| Link Additions | |
|----------------|--|
| 1 | R4,R5 |
| 2 | R4,R1 R4,R5 |
| 3 | R1,R4 R4,R1 R4,R5 |
| 4 | R4,L3 R4,L11 R4,R1 R4,R5 |
| 5 | R4,L3 R4,L10 R4,L11 R4,R1 R4,R5 |
| 6 | R4,L3 R4,L10 R4,L11 R4,R1 R4,R5 R5,R1 |
| 7 | R4,A1 R4,L3 R4,L10 R4,L11 R4,R1 R4,R5 R4,R9 |
| 8 | R4,L3 R4,L10 R4,L11 R4,R1 R4,R3 R4,R5 R4,R9 R9,R1 |
| 9 | L11,R5 R4,A1 R4,L3 R4,L10 R4,L11 R4,O2 R4,R1 R4,R5 R4,R9 |
| 10 | R4,A1 R4,L3 R4,L10 R4,L11 R4,R1 R4,R3 R4,R5 R4,R9 R4,S5 R5,S3 |
| 11 | R4,L3 R4,L10 R4,L11 R4,O3 R4,R1 R4,R3 R4,R5 R4,R9 R5,L3 R5,L9 R5,L11 |
| 12 | R4,L1 R4,L3 R4,L9 R4,L10 R4,L11 R4,R1 R4,R3 R4,R5 R4,R6 R4,R9 R9,R1 R9,R4 |
| 13 | R1,R9 R4,A1 R4,I1 R4,L3 R4,L10 R4,L11 R4,R1 R4,R3 R4,R5 R4,R9 R9,R1 R9,R4 R9,R5 |
| 14 | R4,A1 R4,L3 R4,L10 R4,L11 R4,R1 R4,R5 R4,R9 R4,S5 R5,L10 R5,L11 R5,R1 R5,R9 R9,R1 R9,R4 |
| 15 | I2,S1 R4,L3 R4,L4 R4,L9 R4,L10 R4,L11 R4,R1 R4,R3 R4,R5 R4,R9 R5,L5 R5,L10 R5,R9 R9,R1 R9,R4 |

Table S4. Link additions according to the vulnerability index (labels are defined in Figure 1).

| Link Additions | |
|----------------|--|
| 1 | A4,I3 |
| 2 | A4,R3 L7,A5 |
| 3 | A4,I3 L1,R1 L7,L2 |
| 4 | A4,R3 L1,R1 L8,I3 S5,A5 |
| 5 | A4,I3 L5,R8 L8,S4 L11,R3 O1,L2 |
| 6 | A4,R6 L5,R8 L8,S4 L9,I4 O1,A3 S4,A5 |
| 7 | A4,R5 L1,S2 L4,S5 O1,L2 R3,L7 R9,R1 S5,A5 |
| 8 | A4,R6 A5,I3 L1,S2 L3,S5 L11,R7 R3,L7 R9,R1 S5,A5 |
| 9 | A1,O1 A4,R3 A5,S4 I2,S4 L6,I3 L7,A5 O1,S2 R5,R7 R9,R7 |
| 10 | A2,A5 A4,L10 L6,A1 L6,I3 L8,A5 L11,L7 R1,R9 R5,R7 R9,R1 S2,S5 |
| 11 | A4,S1 L3,A4 L4,A3 L7,R3 L11,R7 O4,I3 R6,S5 R7,S2 S4,A4 S5,A5 S5,L8 |
| 12 | A3,R6 A4,I1 L1,S2 L5,R8 L7,R1 O1,L2 O4,S4 R1,R9 R5,R3 R9,R1 R9,S2 S4,A5 |
| 13 | A1,A3 A1,O1 A4,R5 L1,S2 L3,S2 L5,R8 L11,L7 L11,R3 R4,R3 R9,R1 R9,R6 S4,A5 S5,A5 |
| 14 | A4,R3 L2,S3 L5,L7 L8,S4 O1,S2 R1,L1 R1,R9 R6,R3 R8,I1 R9,I2 R9,R1 R9,R5 S4,A5 S5,A5 |
| 15 | A1,O1 L7,A3 L11,I3 O1,I3 R1,R3 R1,R9 R4,S5 R9,R1 R9,R5 R9,R6 R9,R7 R9,S2 S4,A4 S4,L1 S4,O2 |

Table S5. Link additions based on a weighted combination of betweenness centrality, closeness centrality, eigenvector centrality, and vulnerability index (labels are defined in Figure 1).

| Link Additions | |
|----------------|---|
| 1 | S4,L3 |
| 2 | S4,L3 S5,I1 |
| 3 | R4,R1 S4,I1 S4,L3 |
| 4 | R4,R1 S4,A5 S4,I4 S4,O2 |
| 5 | L3,I1 R1,R4 R1,R5 S4,A4 S4,L3 |
| 6 | R4,A1 R4,L3 R4,R5 R6,R3 S4,I1 S4,L3 |
| 7 | L10,S4 R1,R5 R2,S4 R4,R1 R4,R5 S4,A5 S4,L7 |
| 8 | R1,R3 R4,R1 R4,R5 R5,R1 S4,A4 S4,I1 S4,L3 S4,L9 |
| 9 | A2,L8 R1,R4 R4,R1 R4,R5 S4,A4 S4,I1 S4,I4 S4,L1 S4,O2 |
| 10 | A4,R7 L5,A1 R4,A1 R4,R1 R4,R5 R4,S4 S4,A4 S4,I4 S4,L8 S4,O2 |
| 11 | R1,R9 R4,R1 R4,R5 R4,S5 S4,A4 S4,I1 S4,L5 S4,L7 S4,O2 S4,R2 S4,R7 |
| 12 | R1,R9 R4,A1 R4,R1 R4,R5 R4,R9 R5,I3 R9,R1 S4,A4 S4,I2 S4,L1 S4,L3 S4,L8 |
| 13 | A4,R9 L10,S4 L11,S2 R1,R9 R4,R1 R4,R5 R4,R9 R8,S4 R9,R1 S4,I3 S4,L1 S4,O2 S4,R5 |
| 14 | A2,L3 R1,R9 R4,L4 R4,R1 R4,R9 R4,S3 R4,S4 R9,R1 S4,A3 S4,I1 S4,L1 S4,L8 S4,L9 S4,O5 |
| 15 | A2,S4 L1,A3 O3,S4 R1,R9 R4,L3 R4,R1 R4,R5 R4,R9 R9,R1 R9,R6 S4,I3 S4,L1 S4,L3 S4,L8 S4,R2 |