OPTIMIZING THE PROCESS OF RECOVERY AFTER ROAD NETWORK BREAK-UP

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Introduction

» Four natural disasters in the Zlín region as of 1997 (2006, 2009 and 2010)
» Roads damaged particularly from flooding and landsliding
» As a result the road network of the Zlín region broke up into many separated components (up to 46 in 1997)
» Reconnecting works were conducted without any decision-making support tool

Issue

» Road network is crucial for human society
» Road network is often affected or even damaged when hit by a disaster
» It is necessary to reconnect the cut-off parts of the network over the shortest time possible
» A decision-support tool for crisis managers is needed.

Where do we begin?

» (Natural) disaster has just ceased, information on blocked road links has been collected
» Road network is broken up into several parts
» People and important facilities are without connection to the main network
» One, two or four remedial units are at disposal at several stations and ready to work
» Security actions and reconstructions are about to start, but which route should we take?

Necessary steps:

1. Collect data from the entire network to know which road links are blocked
2. Plan routes for remedial units which are available
3. Repair immediately only the most important road links to secure connectivity of the road network. Other road links can be repaired later.

Point 2 is not at disposal, however. Routes are usually planned from scratch

Why is this issue still so complicated?

» Blocked links may cause road network break up into several isolated components
» This issue is a NP-hard problem, similar to the vehicle routing problem (VRP). Plenty of components as several entry and exit nodes exist in contrast to the common VRP, however.
» NP-hard problems are not solvable (in reasonable time) by deterministic algorithms and therefore it is impossible to obtain the best solution.

This issue viewed from the graph theory

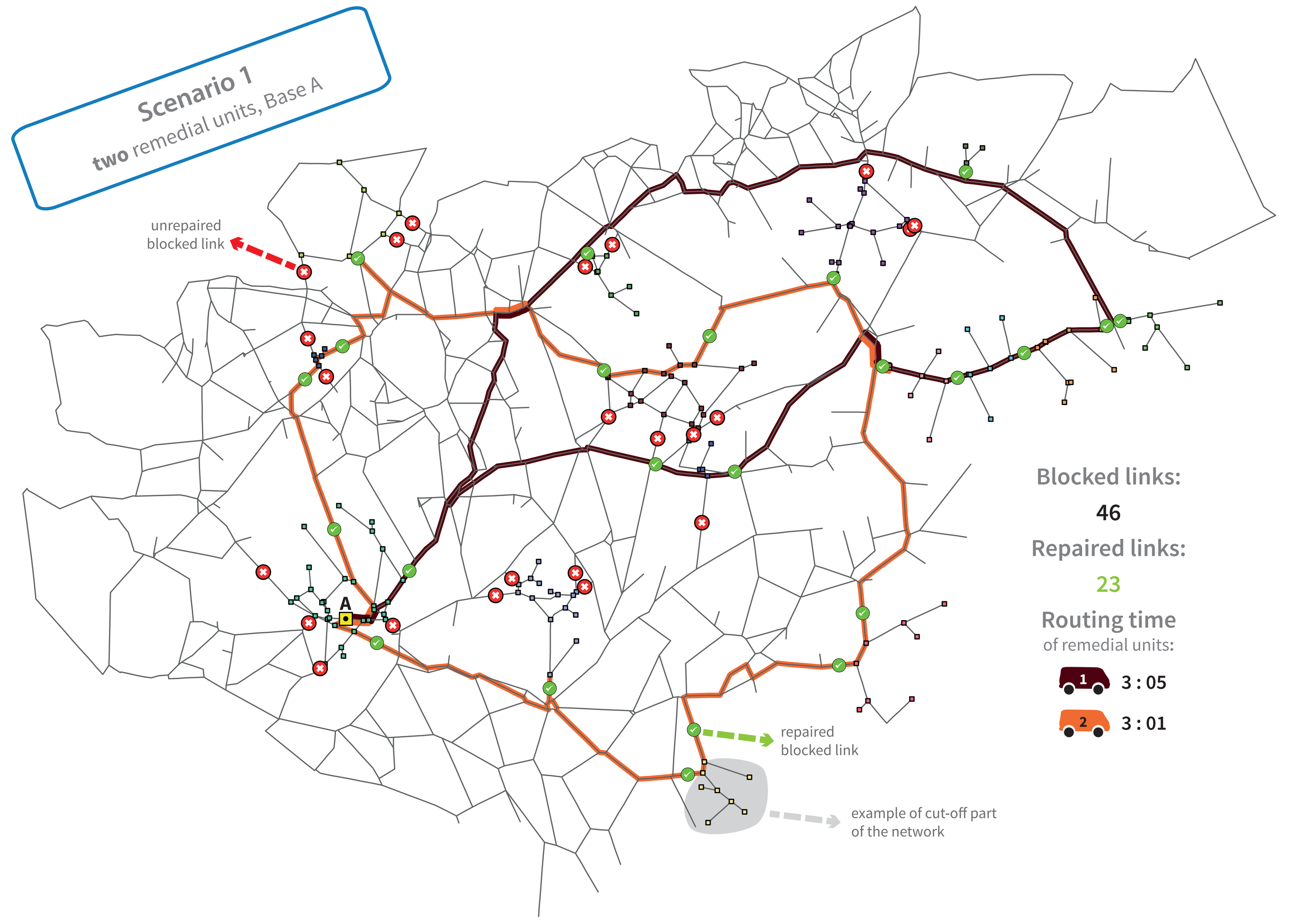
1. A road network with a set of selected links which are understood as blocked.
2. The number and localization of repair units is known in advance.
3. Minimize repair time spent by a unit. If more units are deployed, minimize the longest time.

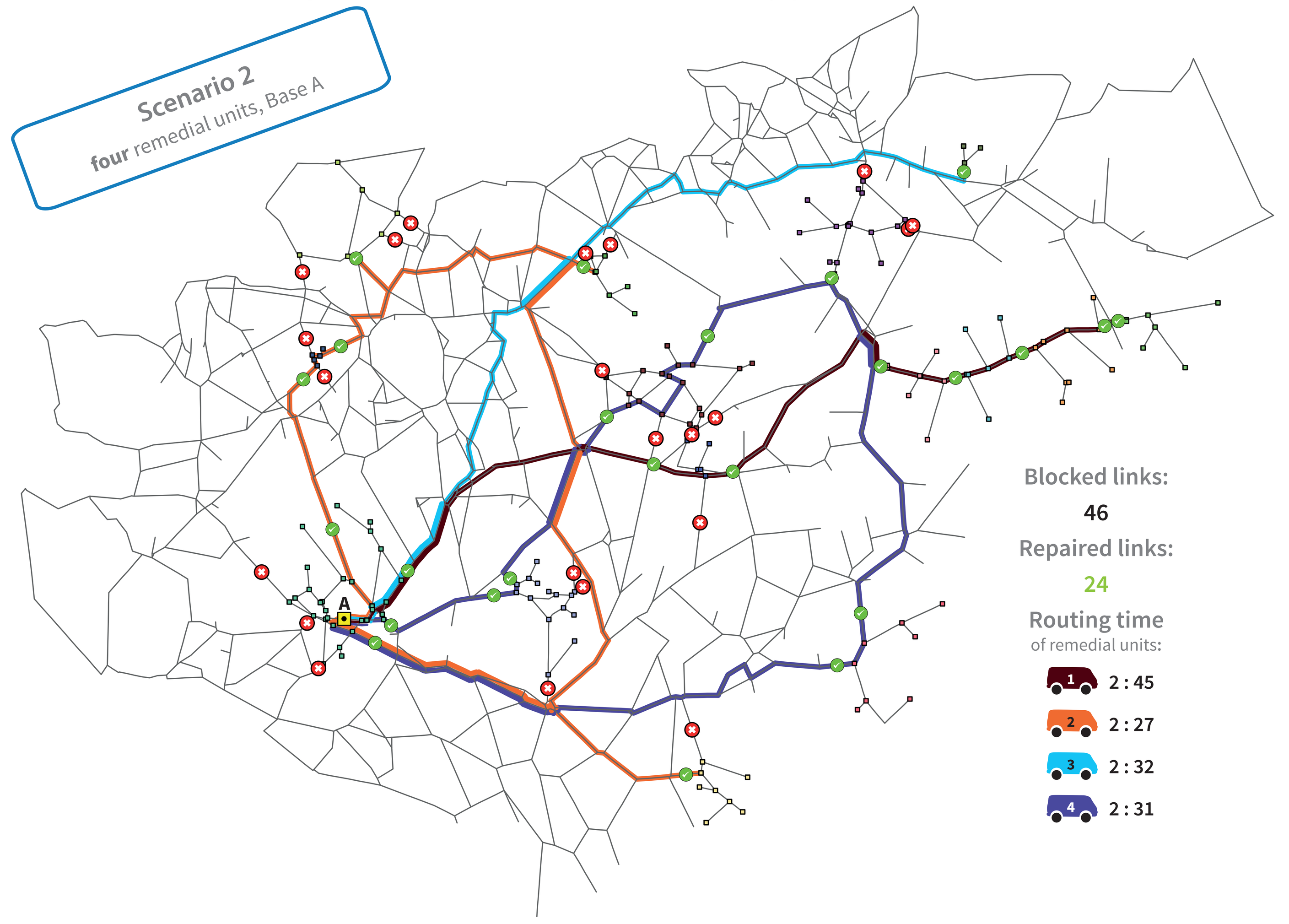
What is our approach?

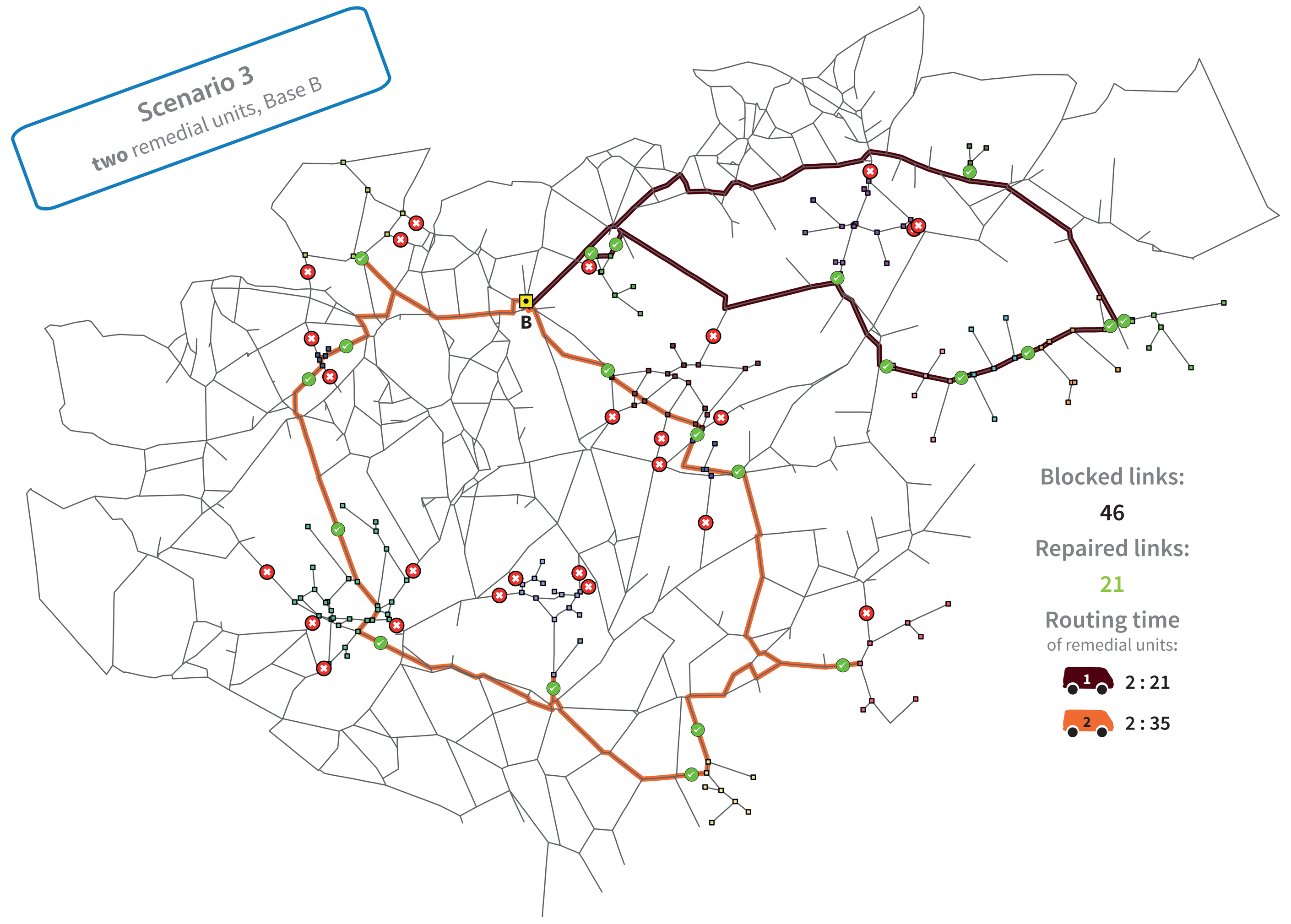
» We search for the solution using sophisticated stochastic algorithm combined with local search procedures.

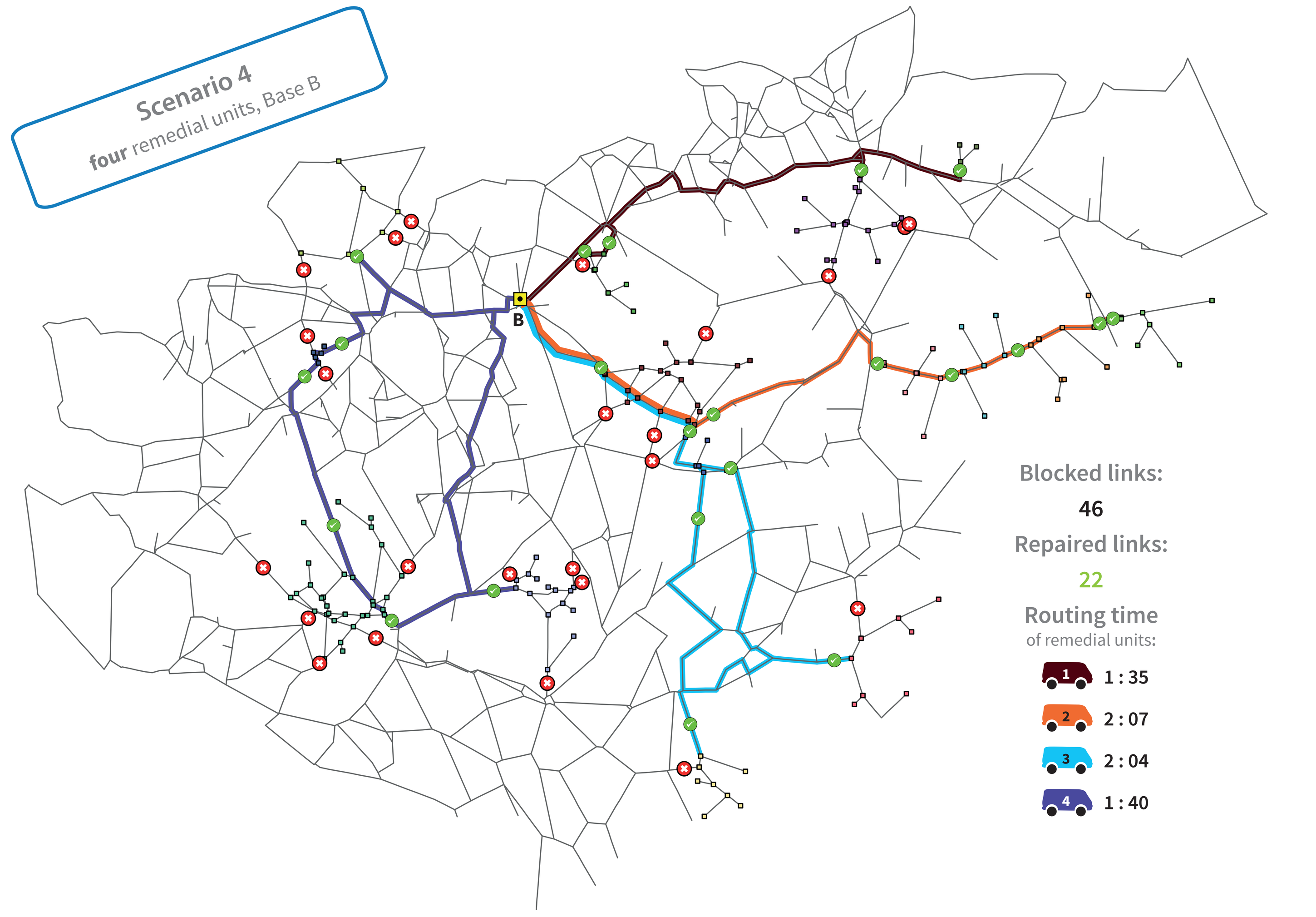
Future works

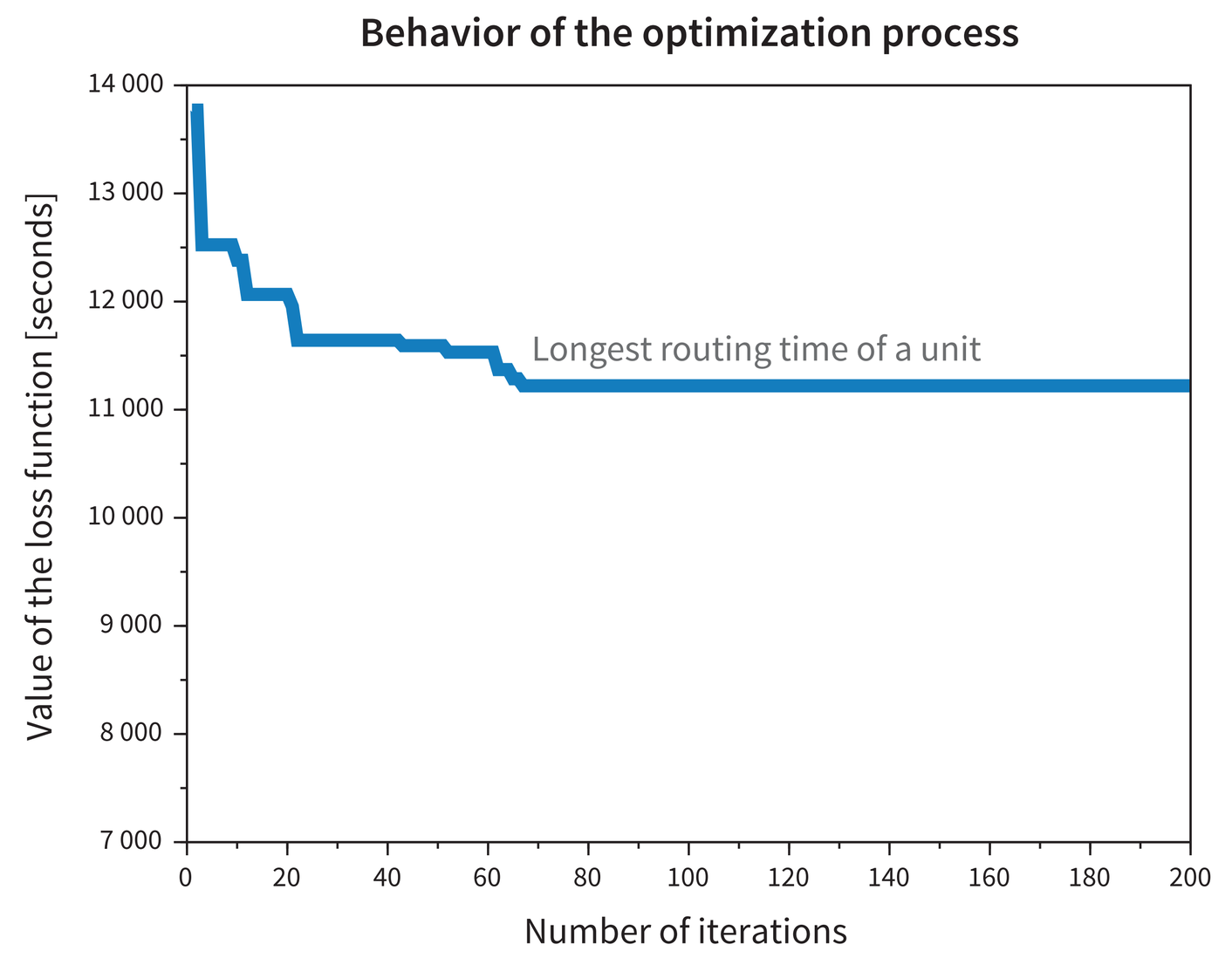
1. Incorporation of time needed for opening (elementary reconstruction to allow connection) of blocked road links.
2. Modification of the loss function and the algorithm to cover further optimization criteria as the number of cut-off people, importance of some nodes for the entire network etc.

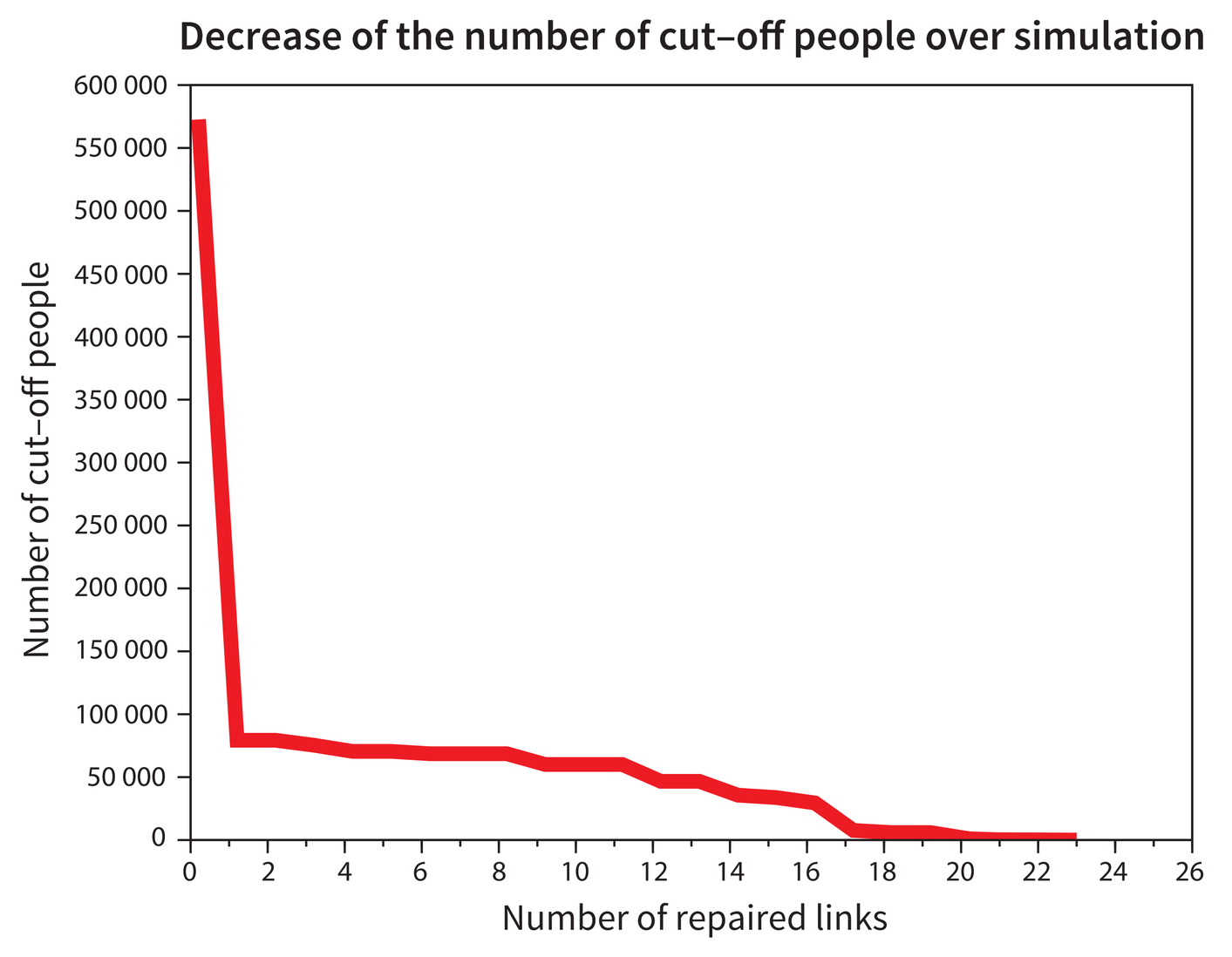


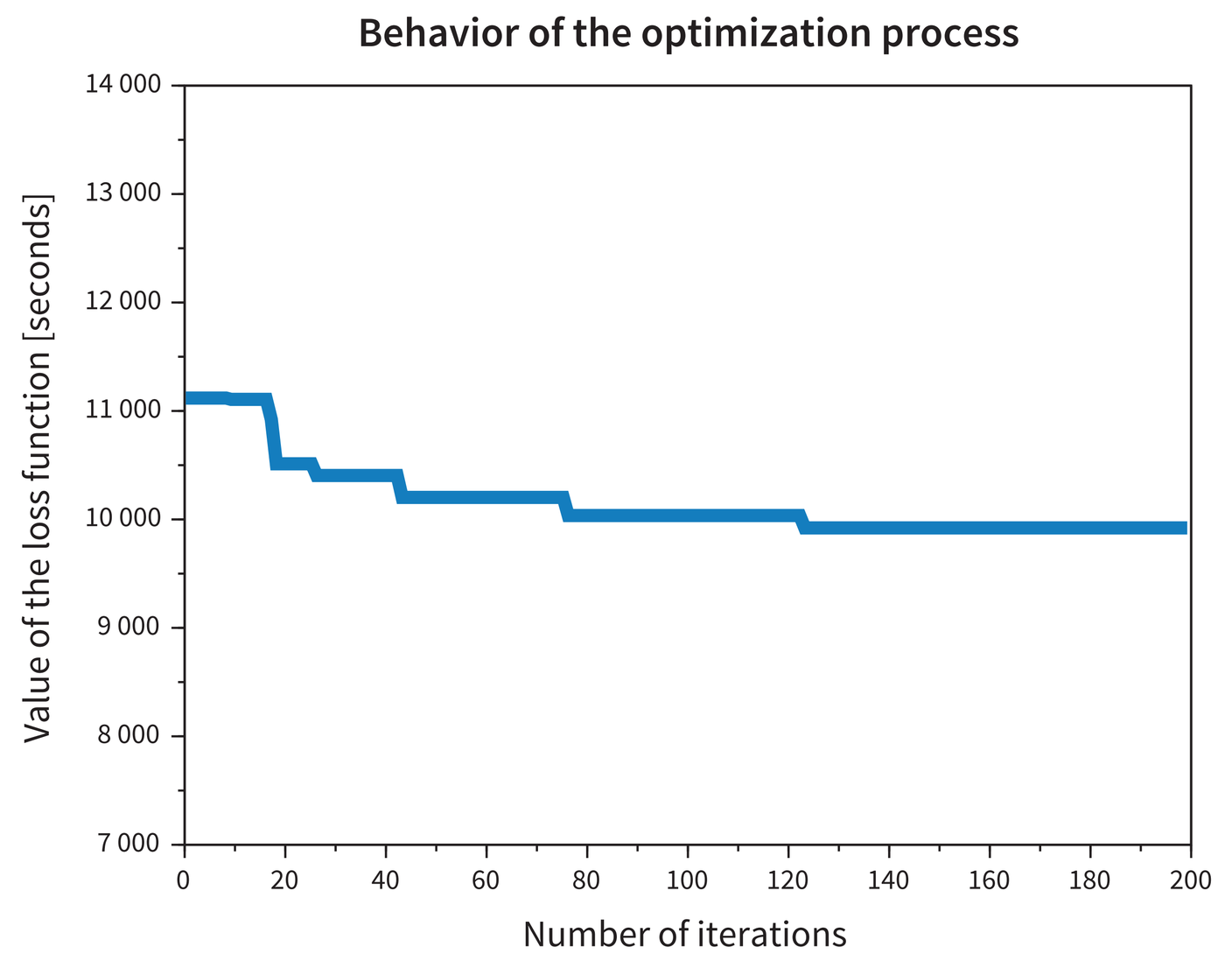


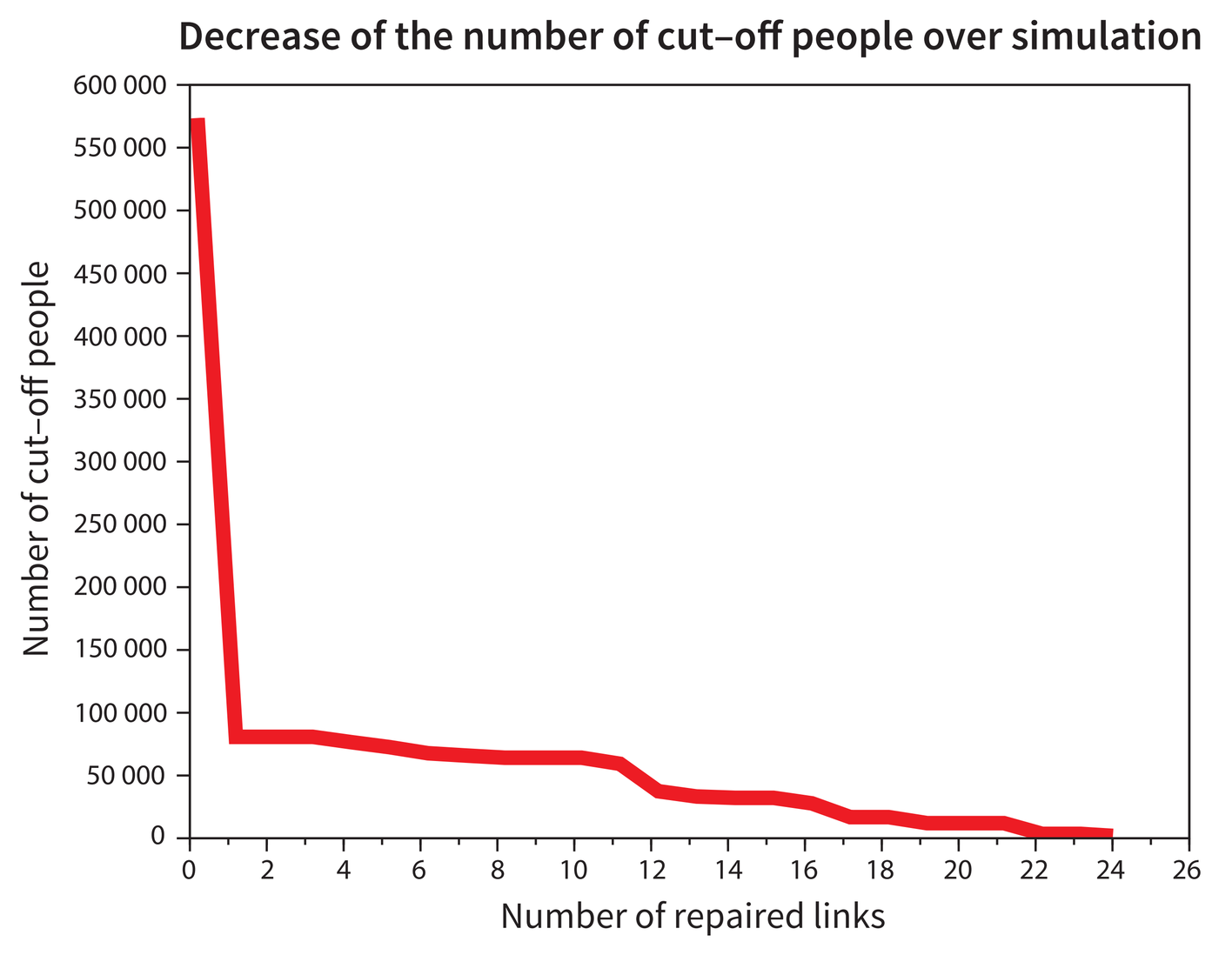


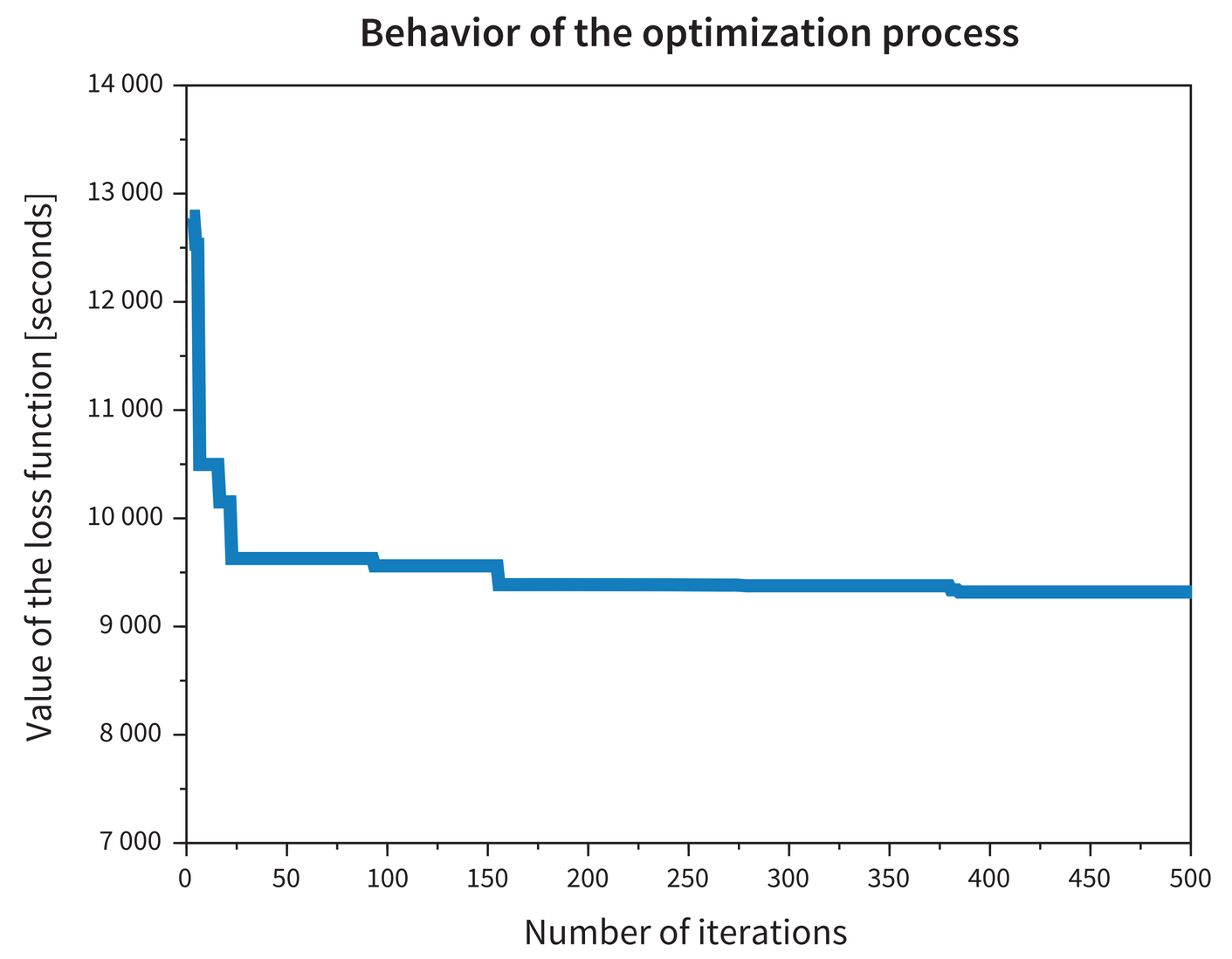


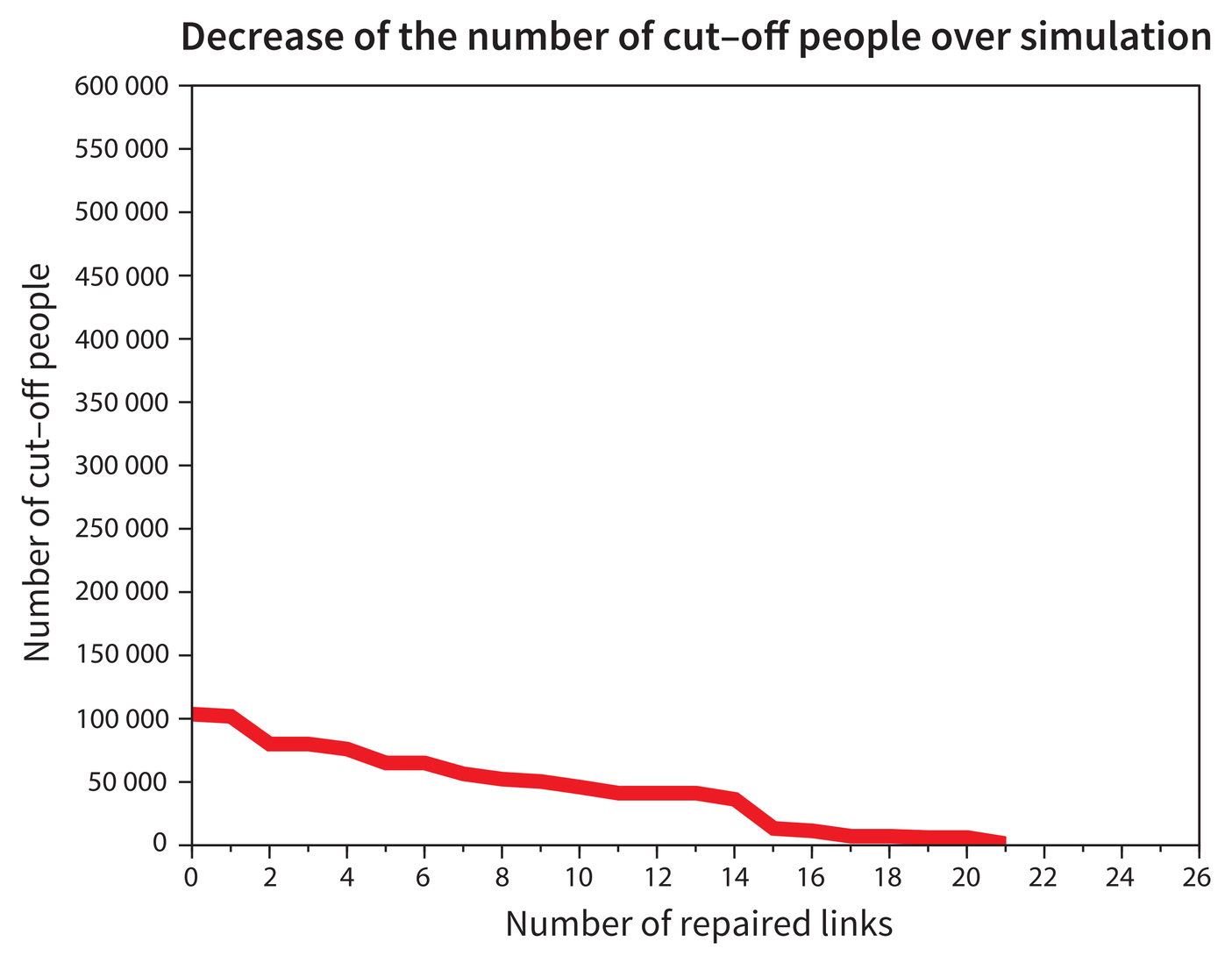


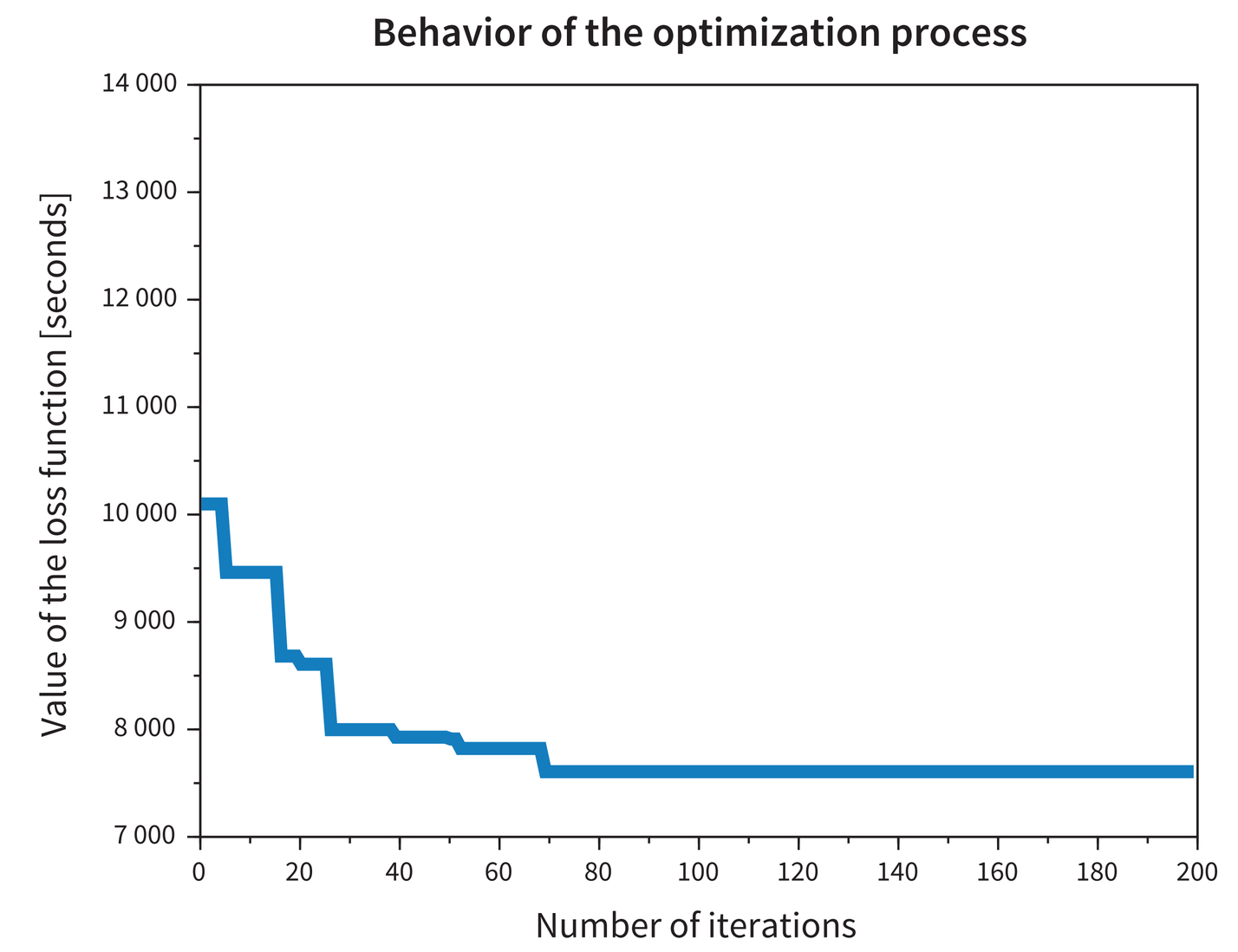


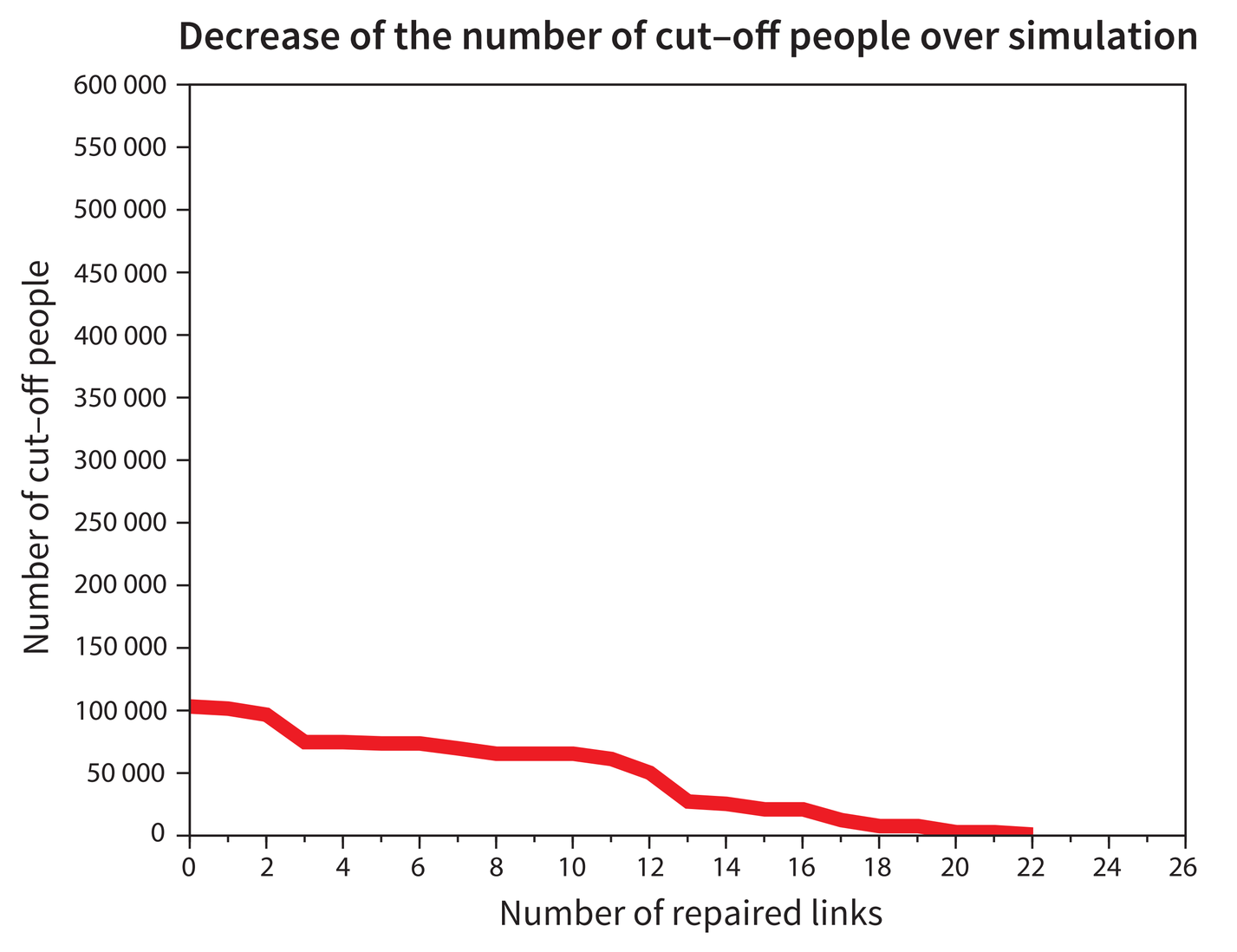












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