ONGOING RESEARCH IN H-C3 SCOPE

Mathematical Network Optimization

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Optimization of the German National Research and Education Network X-WiN

Objective

• Minimize total network cost

Variable decisions

• Which sites host inner and outer core nodes?

• Which connections are set up?

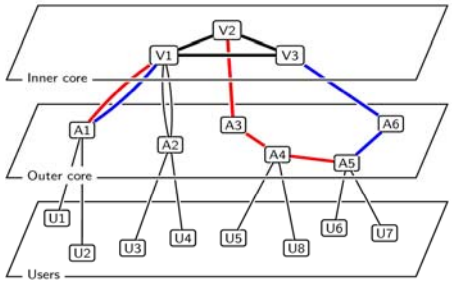
• Which technologies and capacities are installed?

Constraints

• Connect all user sites.

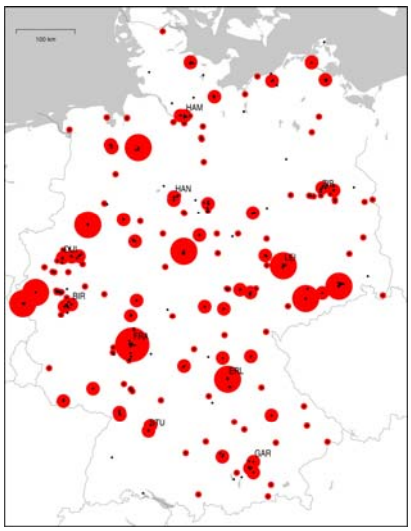
• Dimension sufficiently for all demands.

• Core network must be fault tolerant.

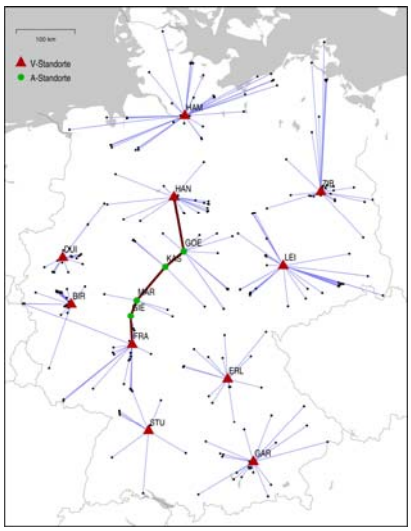


Fault tolerance in the X-WiN network: The inner core network must be biconnected. Each outer core node is connected to the inner core network by two disjoint paths. These paths may contain further outer core nodes and may end at different inner core nodes.

Problem data: User sites with demands and subset of possible core network sites.



Example solution: Assignment of user sites to core nodes and chain of outer core nodes.



Solution Approach

Integer linear programming formulation (ILP)

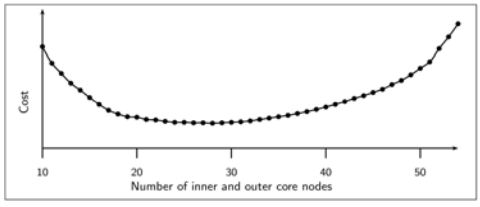
• Variables for all possible $V_1-A_1-\ldots-A_k-V_2$ chains that connect outer core nodes to inner core.

• Link technologies and capacities implicit in variables

Implemented solution procedure

1. Generate all relevant chains (C++/Perl)
   Sophisticated preprocessing allows reduction from > 1 Trillion to < 100000 variables!
2. Generate ILP (Modeling Language ZIMPL)
3. Solve ILP (CPLEX/SCIP)
4. Postprocess and visualize ILP-solution (Perl)

Results



Real-world planning scenarios (up to 400 sites) are solved to optimality within seconds.

Cooperation

DFN Verein zur Förderung eines Deutschen Forschungsnetzes e.V.