Total Network Optimisation

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Overview

'Standard' Optimisation
Total Network Optimisation
Ambitions
Demo

Some optimisation problems

What is the least cost design of the NGWDM network?
What is the optimal strategy for allocating wavelengths?
What is the cheapest way to provide dual parenting ?
What is the least disruptive way to ensure that we do not to exceed BRAS capacity for WBC?
What is the optimal location of GPoPs for Global Access?
What is the least cost supplier mix for providing access in the USA?
What is the optimal design of the 21C core network?
Can we improve the capacity planning policies?
Can we make more efficient use of available capacity by introducing TE mechanisms?

…

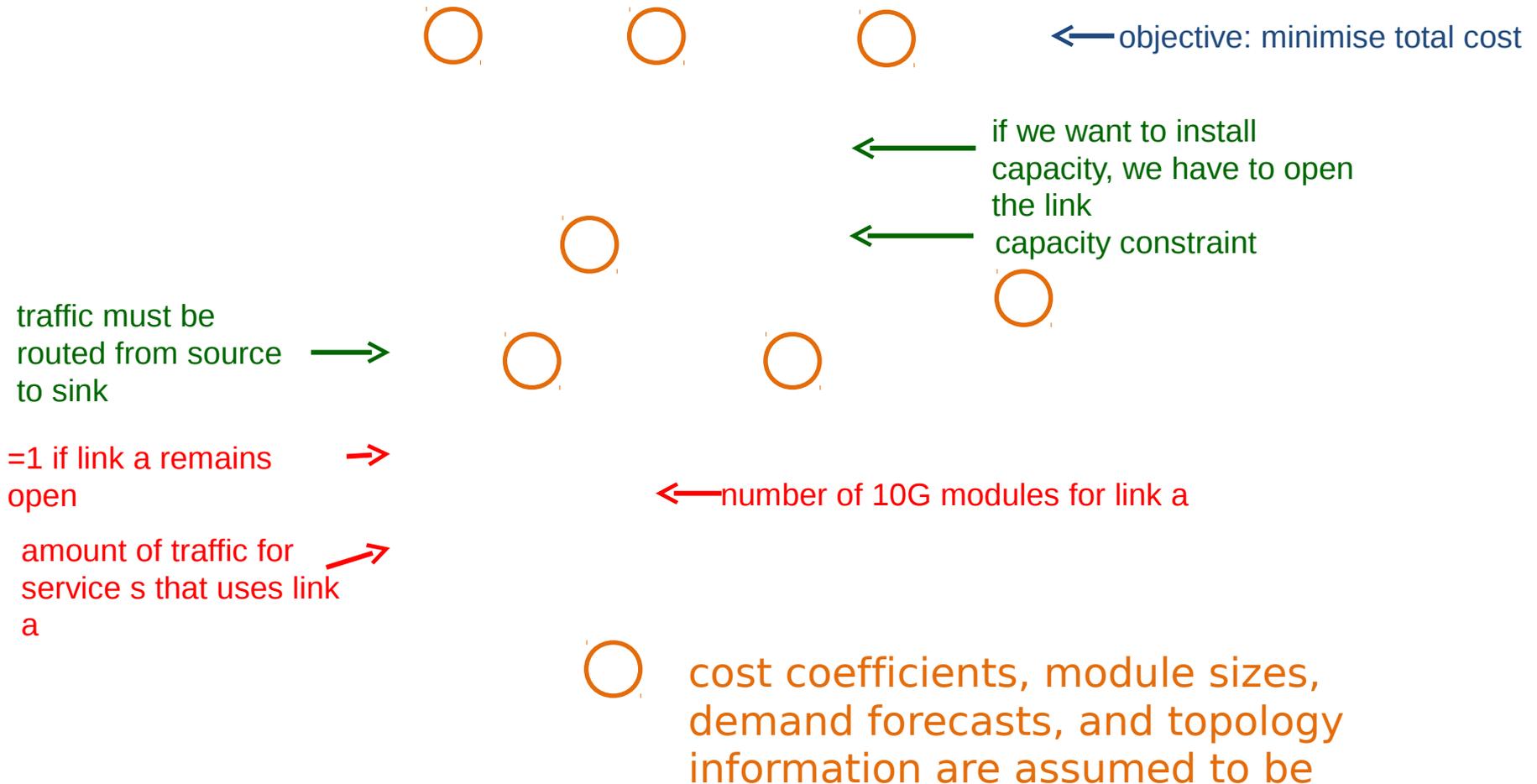# 'Standard' optimisation

Formulate the problem
    precisely capturing scope, objective, and constraints

Obtain the required input data

Use a standard algorithm, or develop a new one

Assess the outcome of the algorithm, possibly resulting in the repeat of one of the earlier steps

As a Mixed Integer Linear Program

objective: minimise total cost

if we want to install capacity, we have to open the link

capacity constraint

traffic must be routed from source to sink

=1 if link a remains open

number of 10G modules for link a

amount of traffic for service s that uses link a

cost coefficients, module sizes, demand forecasts, and topology information are assumed to be

Mathematical Programming

A mature discipline:

Lot of research since the 1940's

Wide variety of application areas, including telecommunications

Huge amount of literature

- best practice as well as new developments

Many optimisation software packages

- commercial and open source
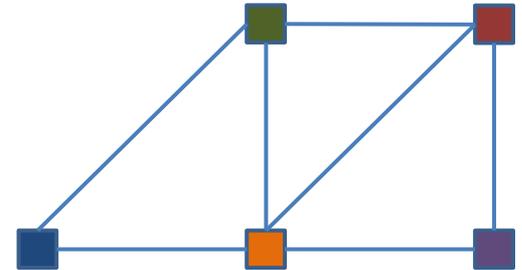
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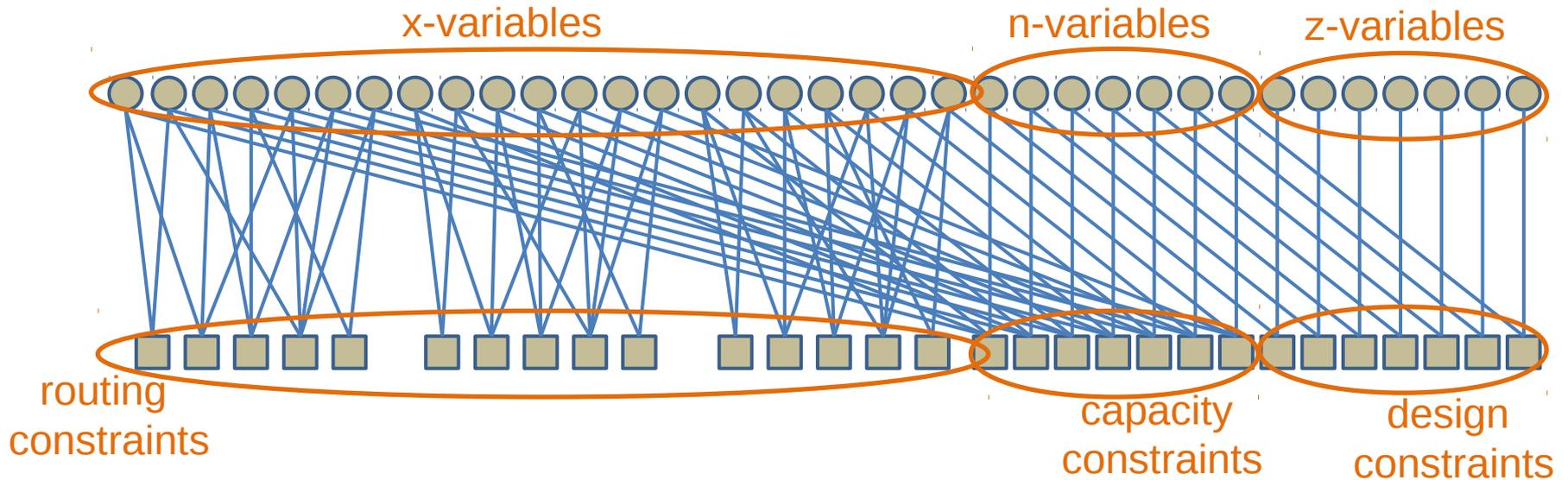Future
Demo

The network design problem

Example:
Initial network with 5 nodes and 7 links
3 services, each with its source and sink

7
   +
7
   +
5x3 =
29 constraints

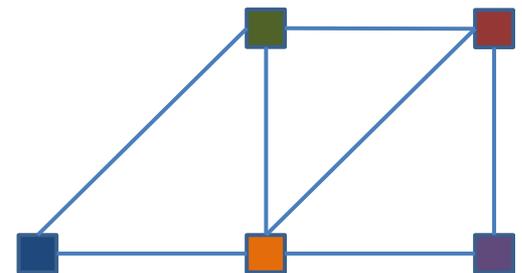7   z-variables
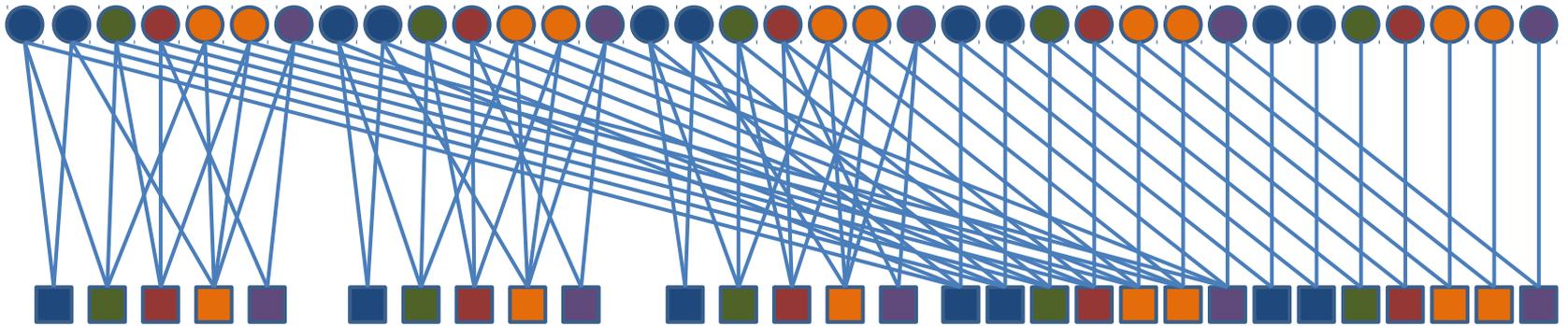7   n-variables
7x3 x-variables
35   total

The Component Graph

x-variables   n-variables   z-variables

routing
constraints

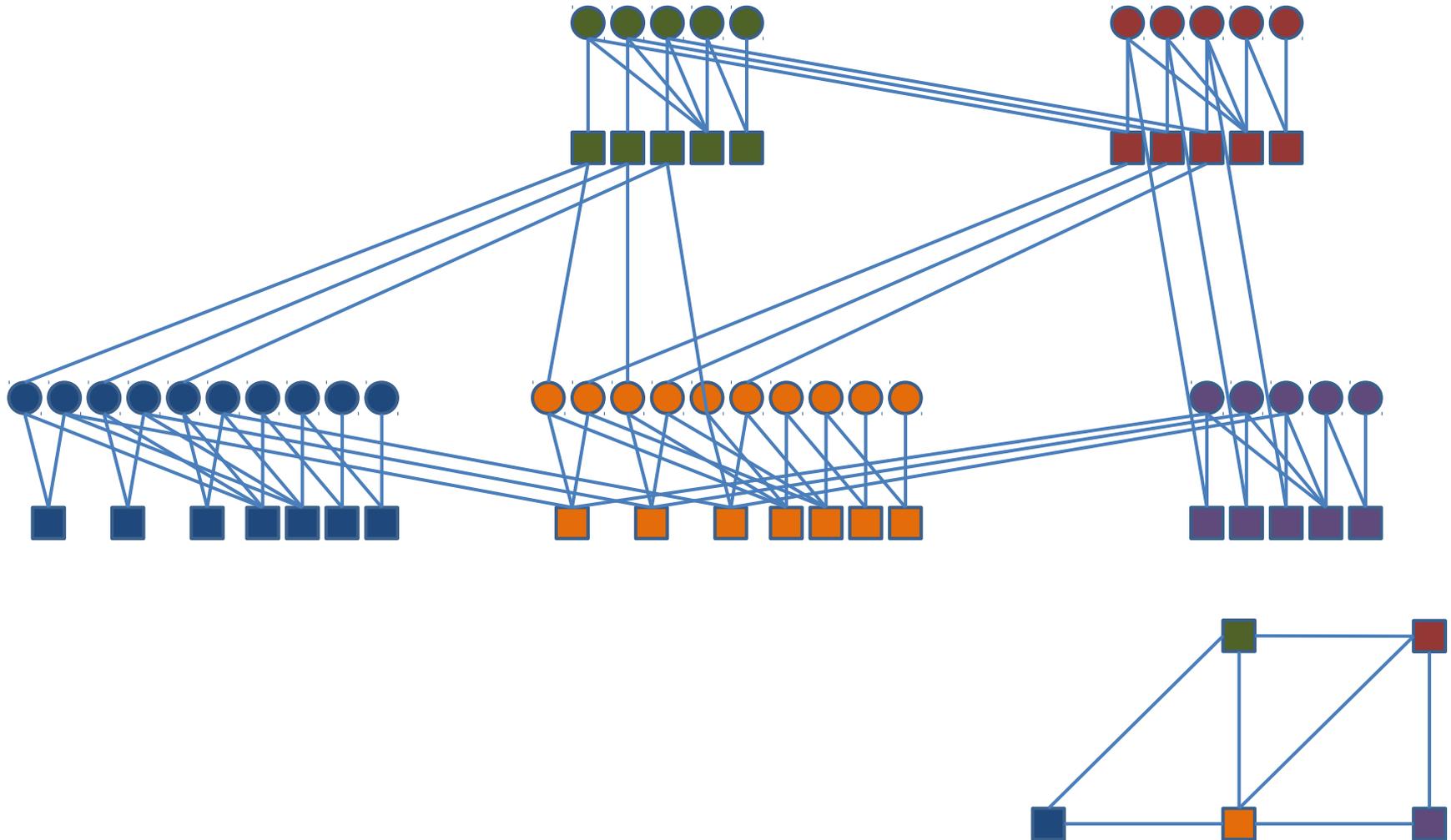capacity
constraints

design
constraints

7
   +
7
   +
5x3 =
29 constraints

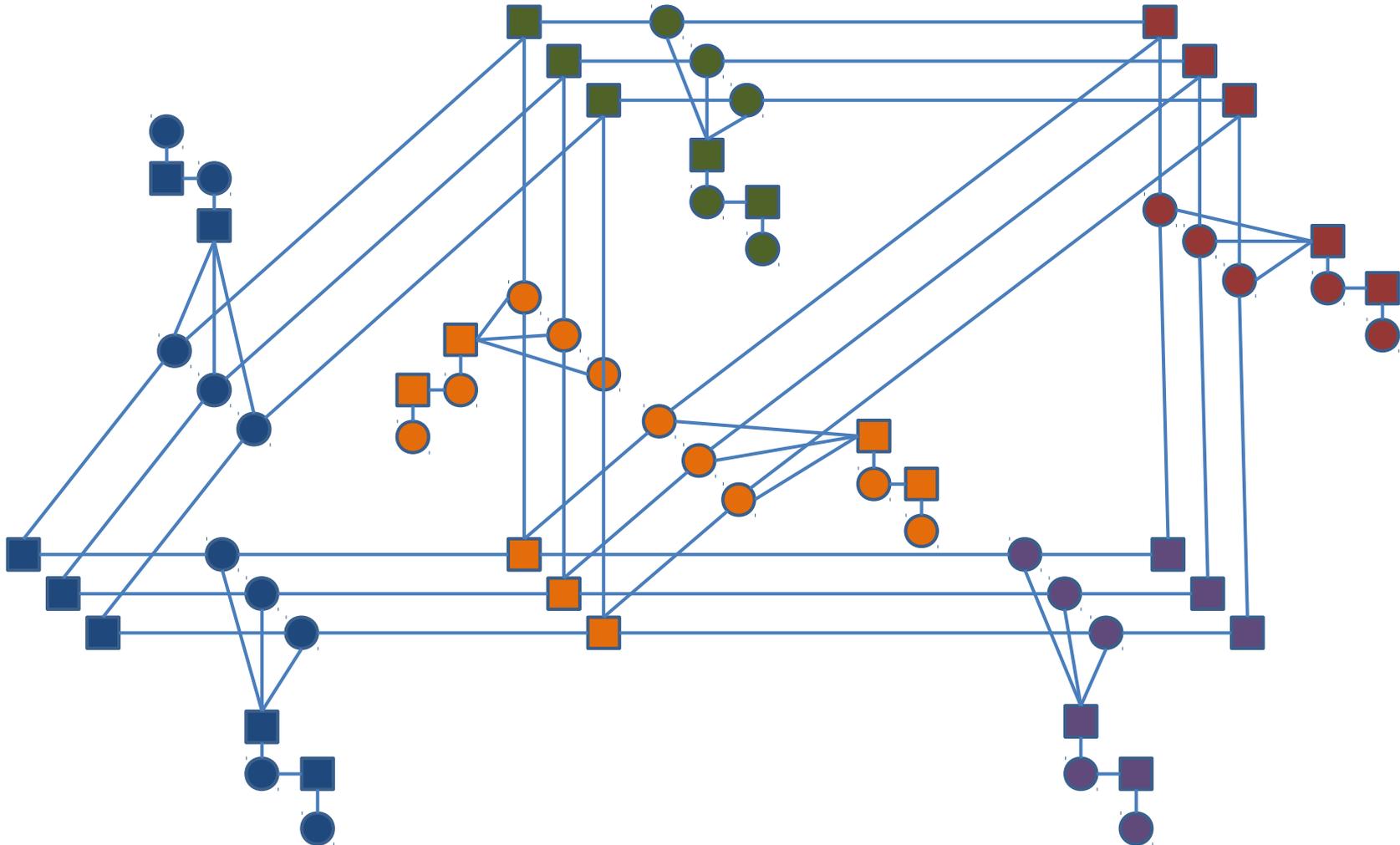7   z-variables
7   n-variables
21 x-variables
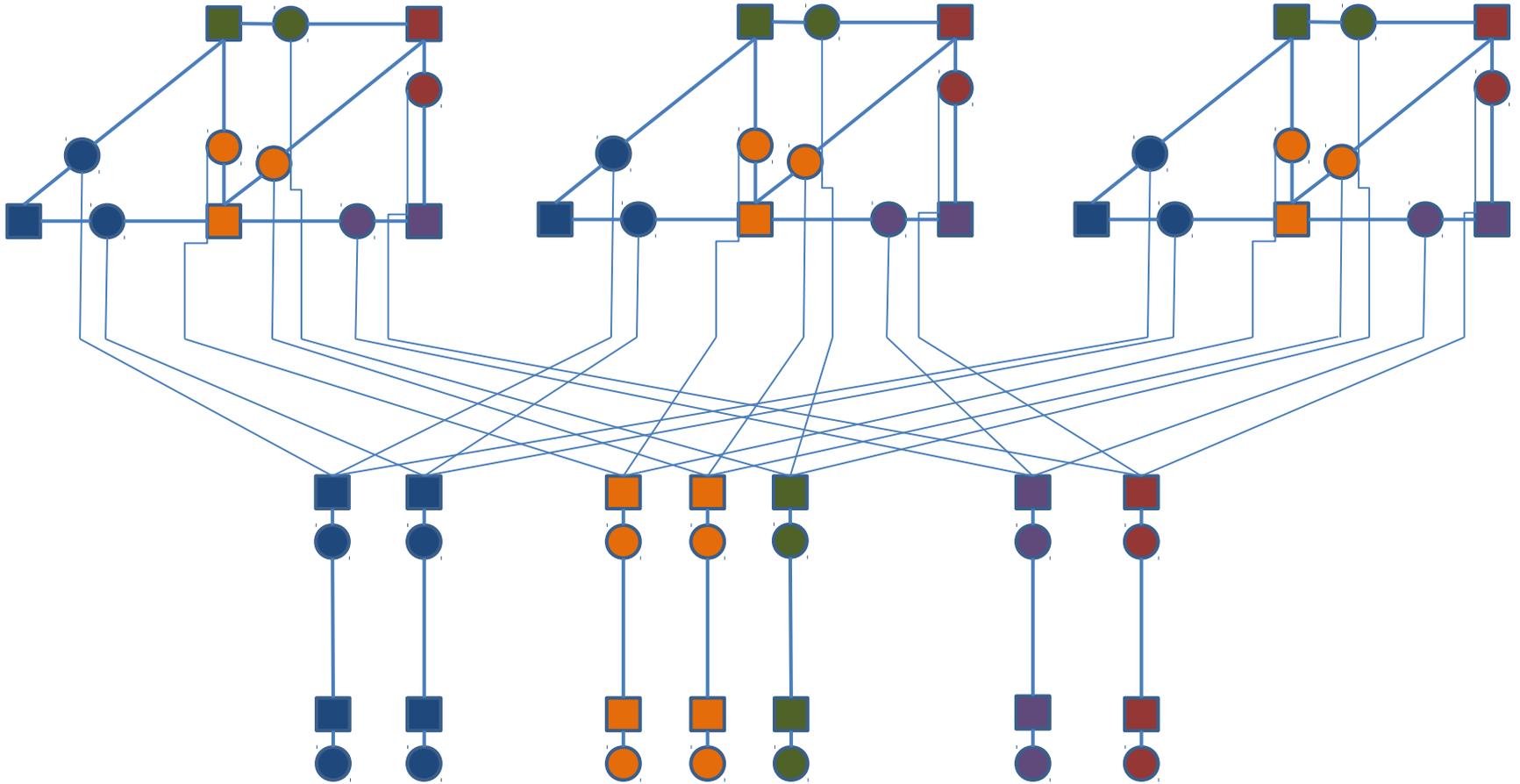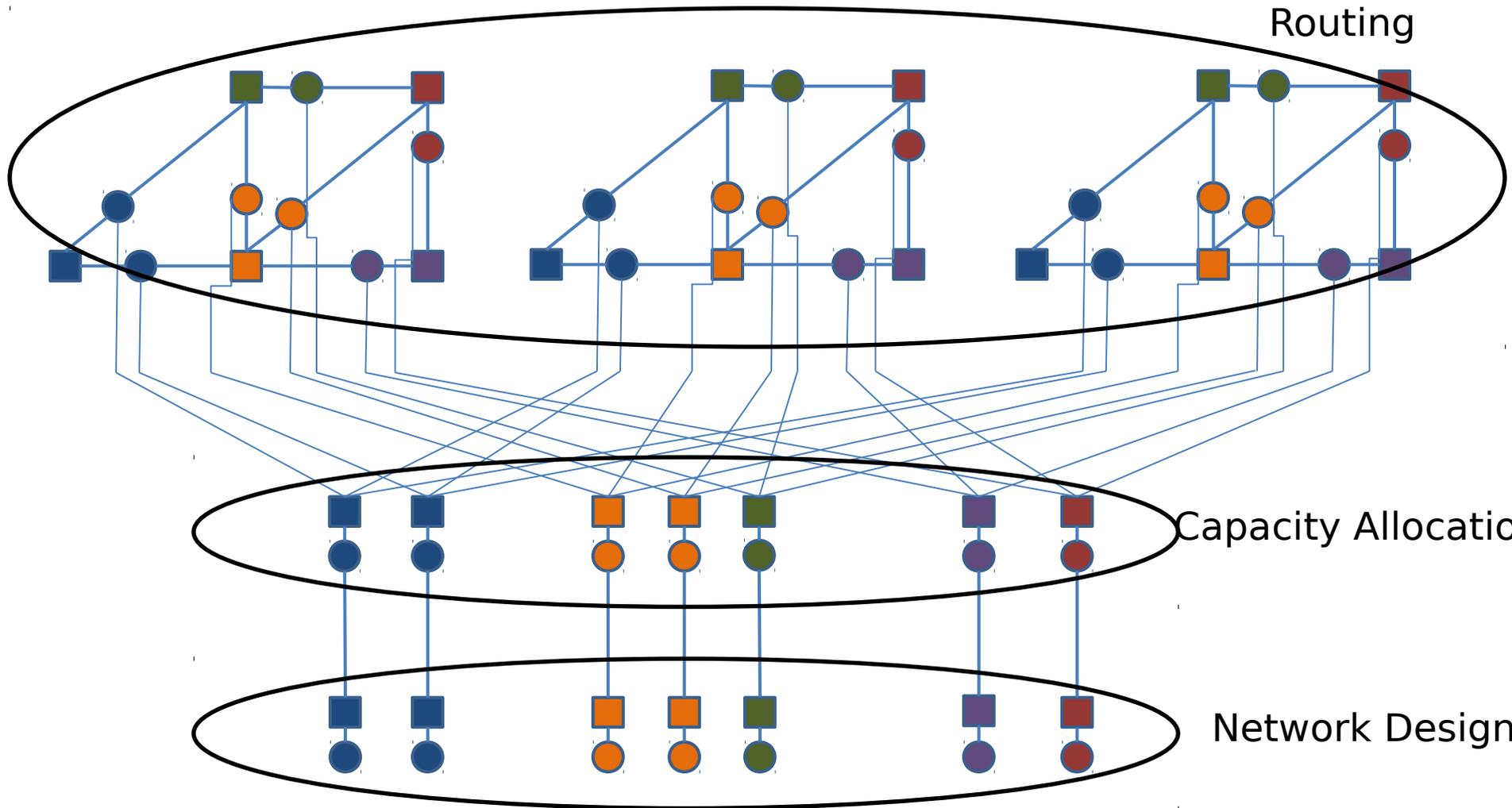35 total

The Component Graph
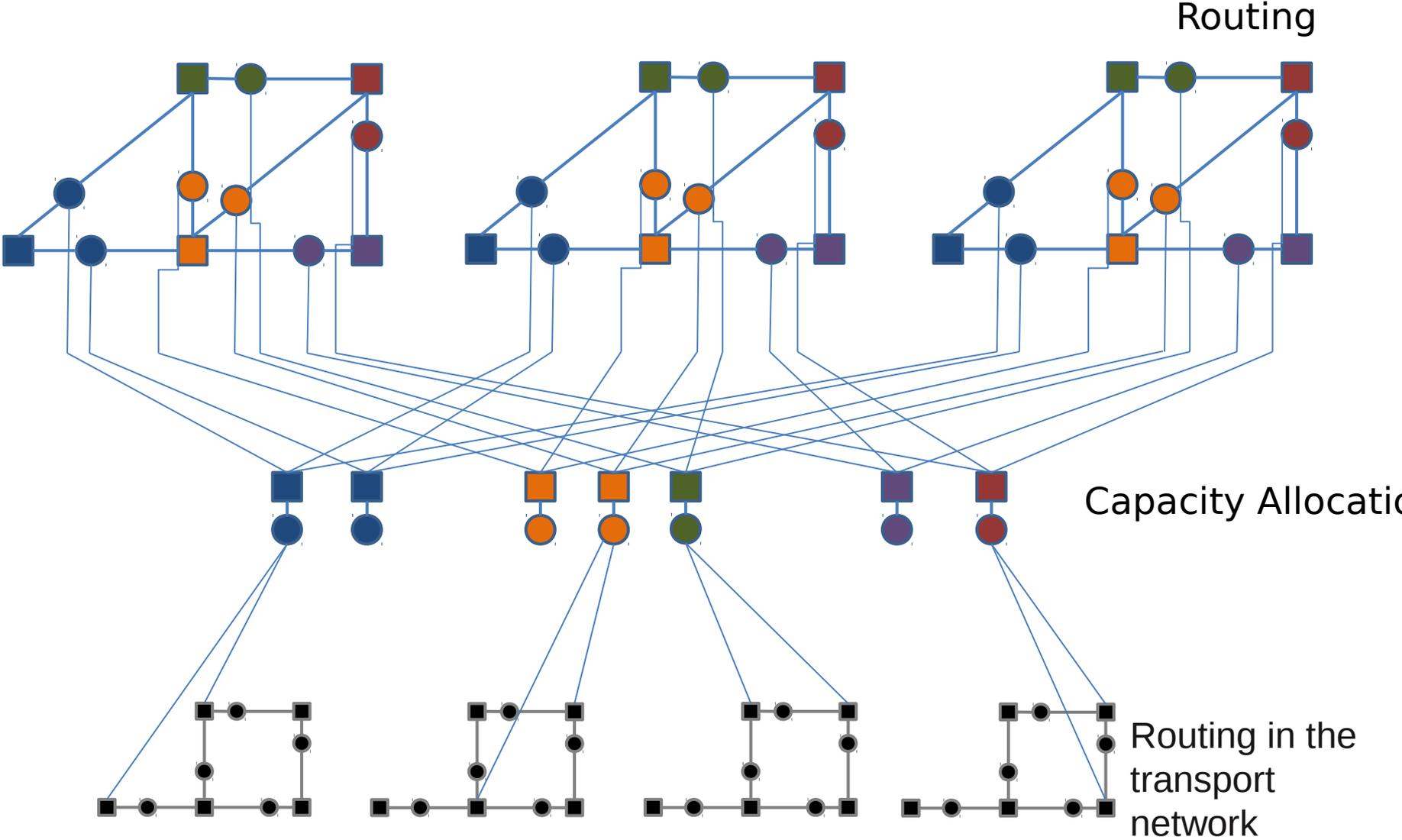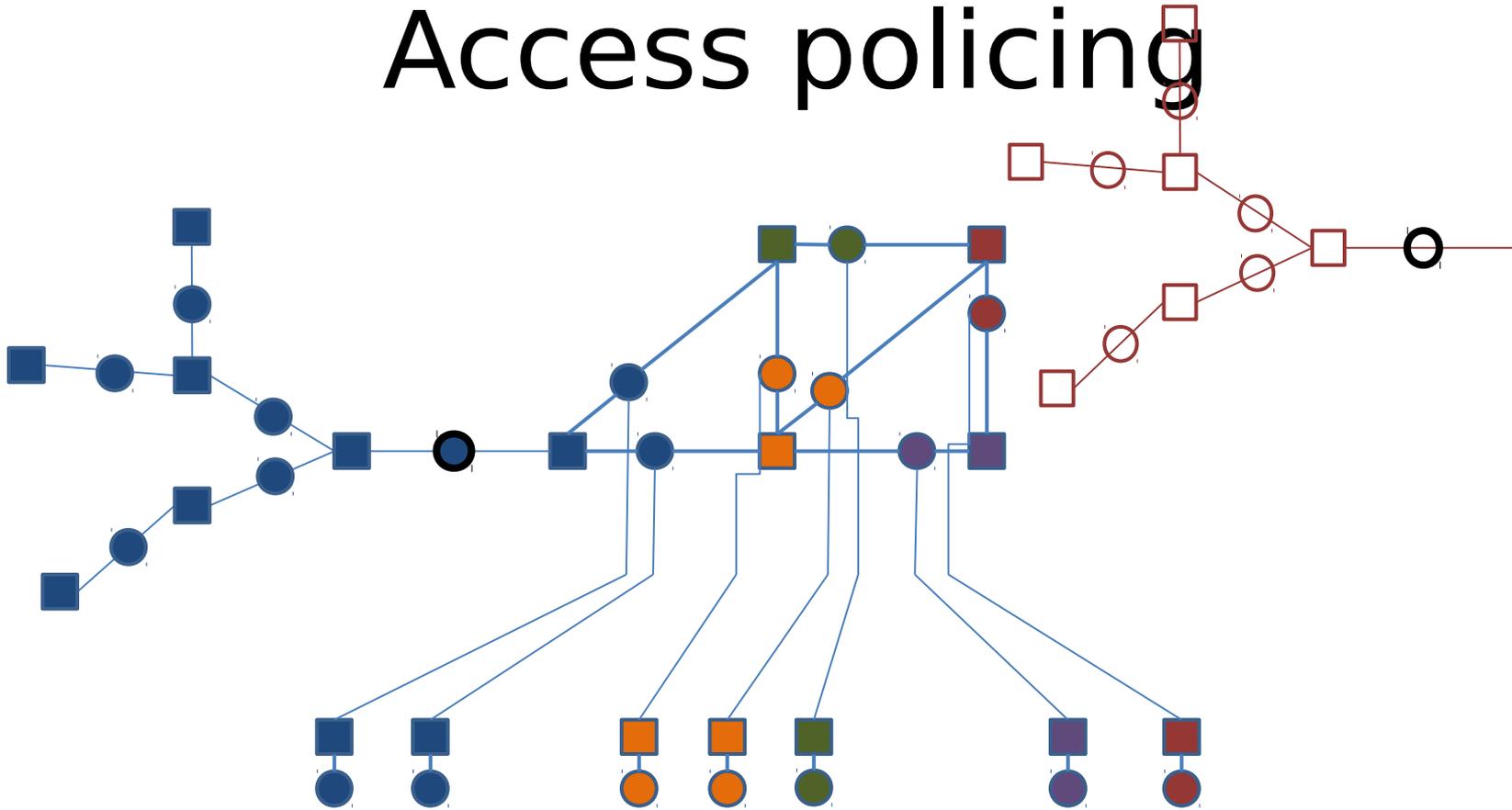
The Component Graph

Another view

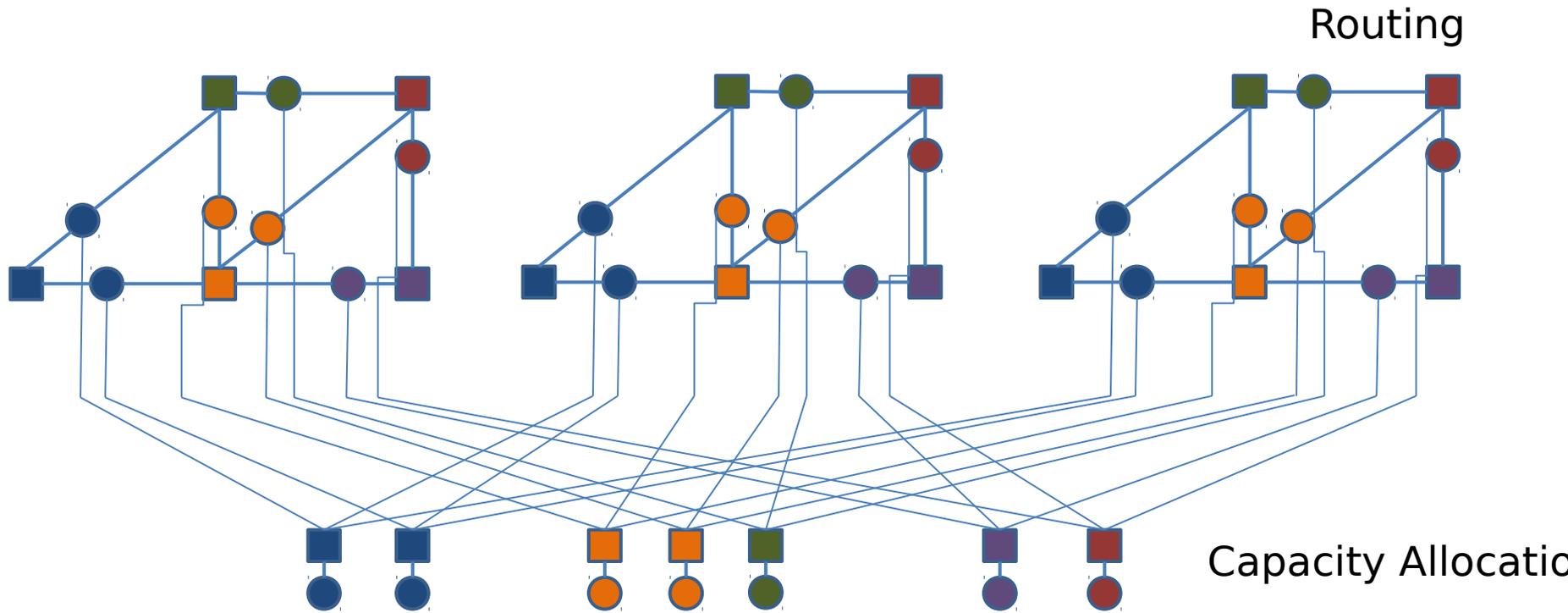# And another view

Optimisation decomposition

Routing

Capacity Allocation

Network Design

Cross-layer Optimisation

Routing

Capacity Allocation

Routing in the transport network

Access policing

Access policing

Routing

Capacity Allocation

Some observations

Almost all network design, management and control processes can be formulated as interdependent optimisation problems

This suggests the existence of a Total Network Optimisation problem

with objective: maximise total revenue minus total cost?

embedded in an environment which is out of our control

This TNO problem cannot be solved using the 'standard' approach

too large, too complex (NP-hard)

defined over different time scales

The best we can hope for is to break the big problem down into smaller sub-problems

taking into account the mentioned interdependencies

and to develop solution methods that operate at the appropriate time scales

We are not aware of a more suitable methodology than that provided by our optimisation decomposition framework

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Future

You need to continue to deal with real time optimisation issues obviously
But starting from the point of optimisation at architecture and planning reduces the need for future optimisation

- 'higher up the food chain'

Total optimisation will be a key part of network design.

- possibly supported by a multi-layer model of the network that is sympathetic to and exposes the interdependencies between different management and control processes

Perhaps tackling the big fundamental problems in network design

- such as multi-layer resilience

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O-M-G! He's going to play a movie in Powerpoint!