

Network Analysis and Telecommunication Applications

Dmitry Shaposhnikov, University of Nizhny Novgorod 2017



Graphs and Networks

Graph

• Common theoretical conception

Network

• Graph in an application



A collection of points joined together in pairs by lines: the points are referred to as *vertices* or *nodes*, lines are referred to as *edges*.

[M.E.J. Newman. Networks – An Introduction. Oxford, University Press, 2010].





Four General Classes









Technological networks

- The Internet and Telecommun. Networks
- Power Grids
- Transportation Networks
- Delivery & Distribution
 Networks

Social Networks

- The vertices are people, or groups of people
- Edges represent some form of social interaction

Information Networks

- The World Wide Web
- Citation Networks

Biological Networks

- Biochemical Networks
- Neural Networks
- Ecological Networks





- Finding the Group of People
- The Data Interchange
 - The Pair Interchange
 - The Use of the Common Resources
- The People Activity Estimation



Internet and World Wide Web







Two principal directions of activity

Analysis

Understanding of the Network Structure and Parameters

Synthesis

Decision Making in Network Construction



Problems of Network Analysis





Problems of Network Synthesis



Review of Network Problems and Solutions (Operations Research)

[Hamdy A. Taha. Operations Research: An Introduction. Pearson Hall, 2010]





Features of data transferring network, which are important for modelling

Cable (pipe) capacity can be huge and more greater than capacity of nodes

• Up to 40 GB/s (theoretically)

The cost of operation does not depend on the amount of resource transferred through the network

• The operation cost is almost constant

There are uplink and downlink traffic

• Downlink traffic is greater, but uplink traffic is increasing

Communication node is unite device (for both uplink and downlink)

Multiplexing

Subscribers are connected practically to each node

• The number of subscribers may be huge



Regional Data Transmittion Networks



- Features of Regional Networks
 - Oriented edges (cables and pipes)
 - The number of subscribers may be huge
 - Subscribers can be connected to several nodes (other nodes are transit)
 - The regional network may be connected to transit providers by several nodes



Decision Making of Network: Stages of Problem Solving

Estimation of the Quality of Existing Network

- Multicriteria estimation based on hierarchical system of marks
- Accounting for the interests of subscribers as the services provided
- •Qualitative information on preferences

Network Modification Planning for Quality Increasing

- Modification Problem Solving
- Topology Modification
- Capacity Modification
- Network Activity
 Planning

Estimation: is it necessary?

Modification of Capacity

Modification of Topology







Objects and criteria





Way of subscriber estimation construction

- The subscriber estimation may be:
 - $q_j(x) = 0$, if *j*-th parameter does not satisfy the minimal requirements;
 - − $q_j(x) \in [1,2]$, if *j*-th parameter is higher than minimal requirements.



Topology Modification Problem Solving



- Problem of Pareto set constructing:
 - Variable parameters potential nodes
 - Objectives:
 - The cost
 - The capacity





The End