25th Umbrella Symposium

for the Development of Joint Cooperation Ideas

„Modeling and Simulation with emphasis on High PerformanceComputing and Grid Computing"

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Title: Modeling and Simulation in Water Distribution Systems Engineering

A water distribution system is an interconnected collection of sources, pipes, and hydraulic control elements (e.g., pumps, valves, regulators, tanks) delivering consumers prescribed water quantities at desired pressures and qualities. Such systems are often described as a graph, with the links representing the pipes, and the nodes defining connections between pipes, hydraulic control elements, consumers, and sources. The behavior of a water distribution system is governed by: (1) the physical laws which describe the flow relationships in the pipes and the hydraulic control elements, (2) the consumer demands, and (3) the system's layout. Management problems associated with water distribution systems can be classified into: (1) layout (system connectivity/topology); (2) design (system sizing given a layout); and (3) operation (system operation given a design). On top of those, problems related to aggregation, maintenance, reliability, unsteady flow and security can be identified for gravity, and/or pumping, and/or storage branched/looped water distribution systems. Flow and head, or flow, head, and water quality can be considered for one or multiple loading scenarios, taking into consideration inputs/outputs as deterministic or stochastic variables-for policy or real-time control. The typical high number of constraints and decision variables, the nonlinearity, and the non-smoothness of the head-flow-quality governing equations are inherent to water distribution systems planning and management problems. An example of this is the optimal design problem of a water distribution system defined as finding the water distribution system's component characteristics (e.g., pipe diameters, pump heads and maximum power, reservoir storage volumes, etc.), which minimize the system capital and operational costs, such that the system hydraulic laws are maintained (i.e., Kirchoff's Laws No. 1 and 2 for continuity of flow and energy, respectively), and constraints on quantities and pressures at the consumer nodes are fulfilled. Traditional methods for solving water distribution systems management problems used linear/nonlinear optimization

schemes which were limited in systems size, number of constraints, and number of loading conditions. More recent methodologies are employing heuristic optimization techniques such as genetic algorithms or ant colony as stand alone or hybrid data driven-heuristic schemes. This talk reviews the literature and studies of the author and his group (www.technion.ac.il/~avi/avi.htm, PDF files password: timna) on this topic, and suggests future research directions in this area.