

Wireless Sensor Networks

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Invalid Input

$$25 \times 60 \leq (20 - 25) \times 512000$$

The screenshot shows a software window titled "Sensor Network" with several tabs: "Sensor Network", "Heuristic Vs. PBA", "Heuristic Vs. PBA (1)", "Heuristic Vs. PBA (2)", and "Tr vs. Nmin". The "Sensor Network" tab is active, displaying a large empty box on the left and a control panel on the right. The control panel includes input fields for network parameters, a "Print Sensor Network" button, and a "PBA -- Compute Max Flow" button. A message at the bottom left states: "Input fails $pq \cdot 400 \leq (N_{\min} - p) \cdot m$. Please re-enter."

Sensor Network

Sensor Network

Input Data

Input width of network: 50

Input height of network: 50

Input # of data generators (DGs): 25

Input # of sensor nodes: 20

Input transmission range: 13

Input # of data items for each DG: 60

Input storage capacity for each non-DG: 512000

Min initial energy of nodes: 46

Max initial energy of nodes: 57

Print Sensor Network

PBA -- Compute Max Flow

Path

Blue DG

Red Sensor

Minimum Energy Consumption

Minimum Number of Hops

Minimum Distance

Input fails $pq \cdot 400 \leq (N_{\min} - p) \cdot m$. Please re-enter.

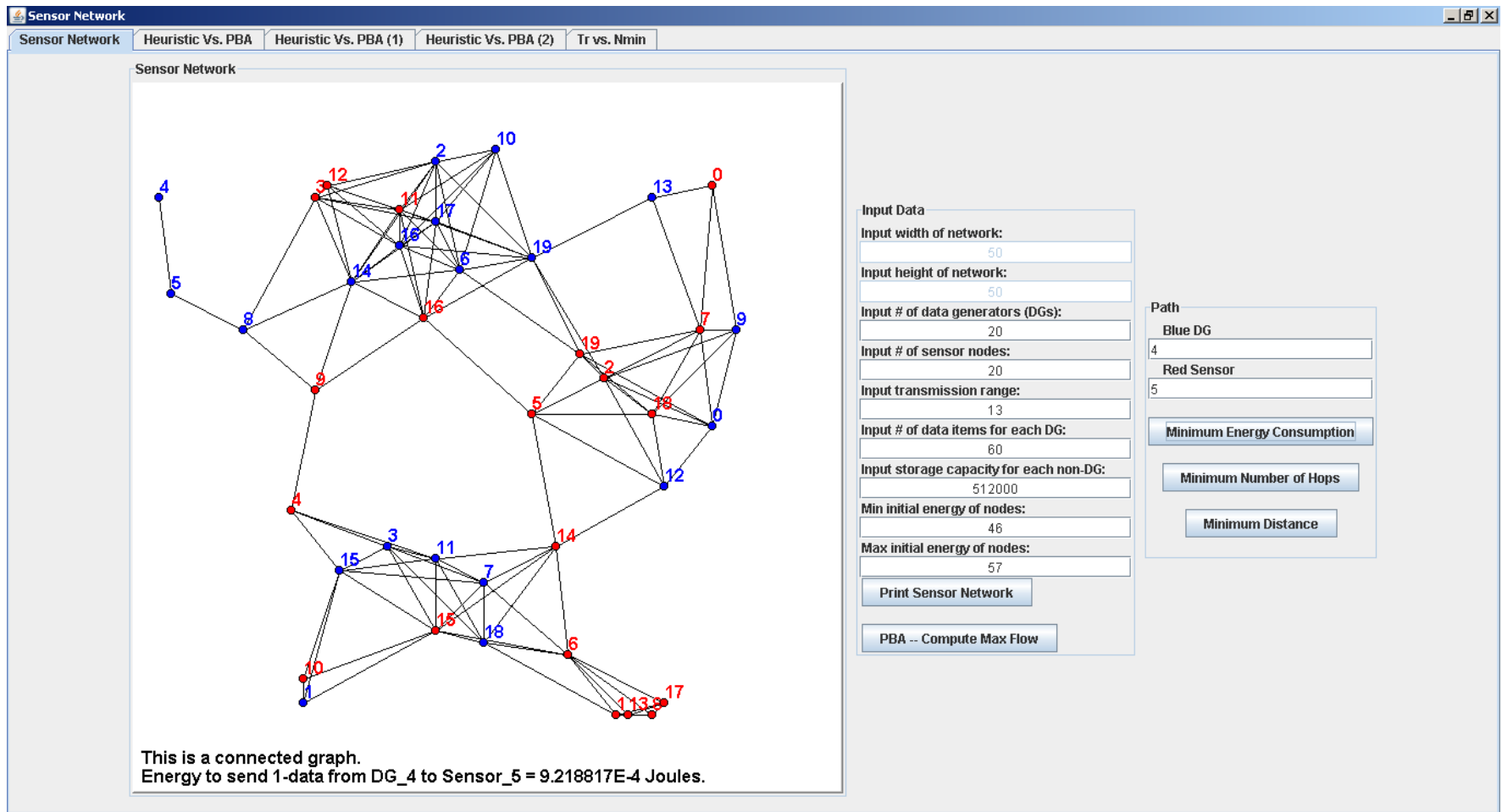
Connected Network

- Shortest path calculations implemented using a minimum priority queue Dijkstra algorithm
- $O(\log V)$ running time for traversing the queue with V number of vertices $(p+q) + E$ edges ($E \leq (p+q)^2$)
- $O([V+E] \log V) = O(E \log V)$ running time

Minimum Energy Consumption

DG 4 to Sensor Node 5

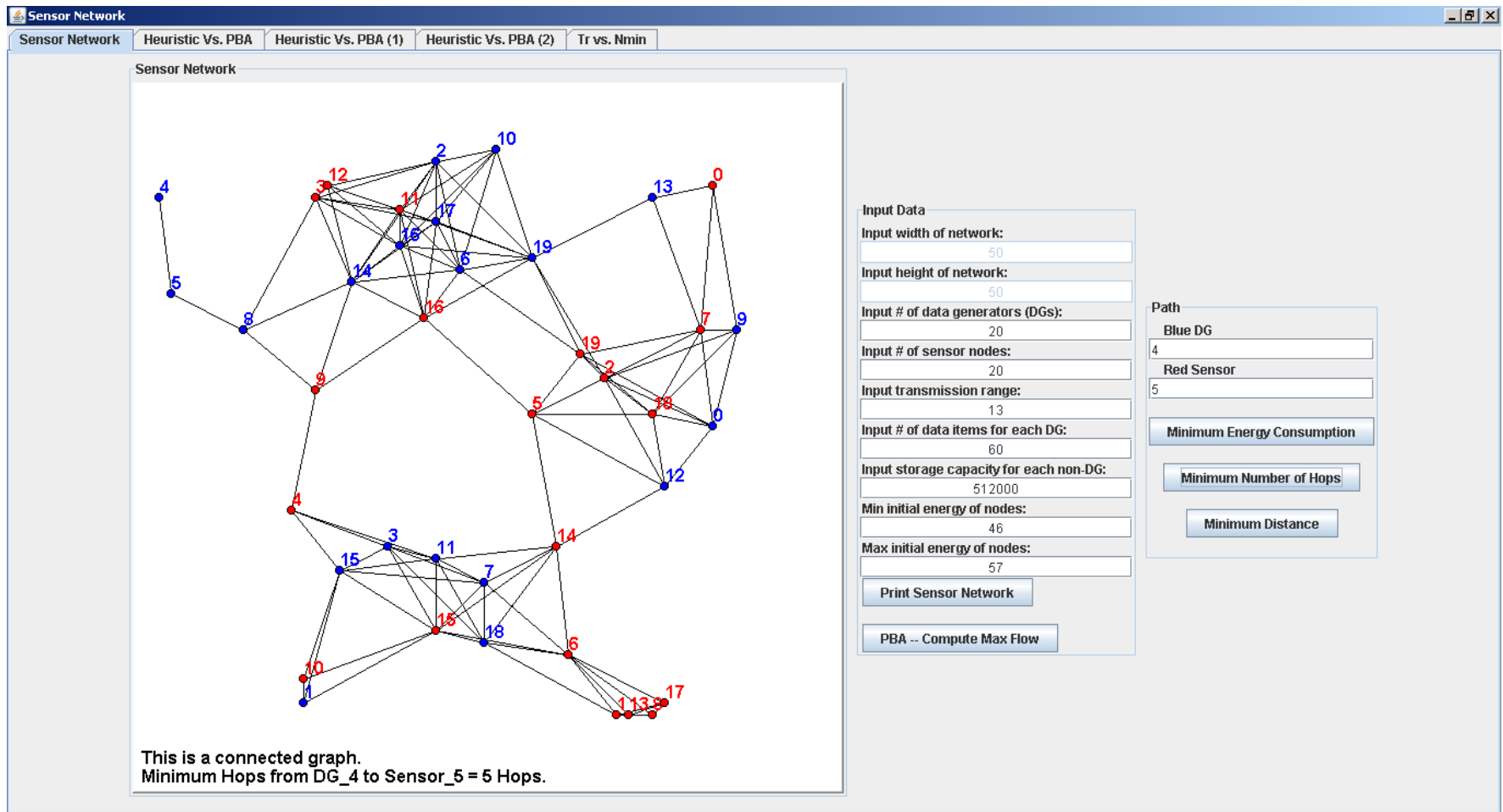
9.218817E-4



Minimum Number of Hops

Blue DG 4 to Red Sensor Node 5

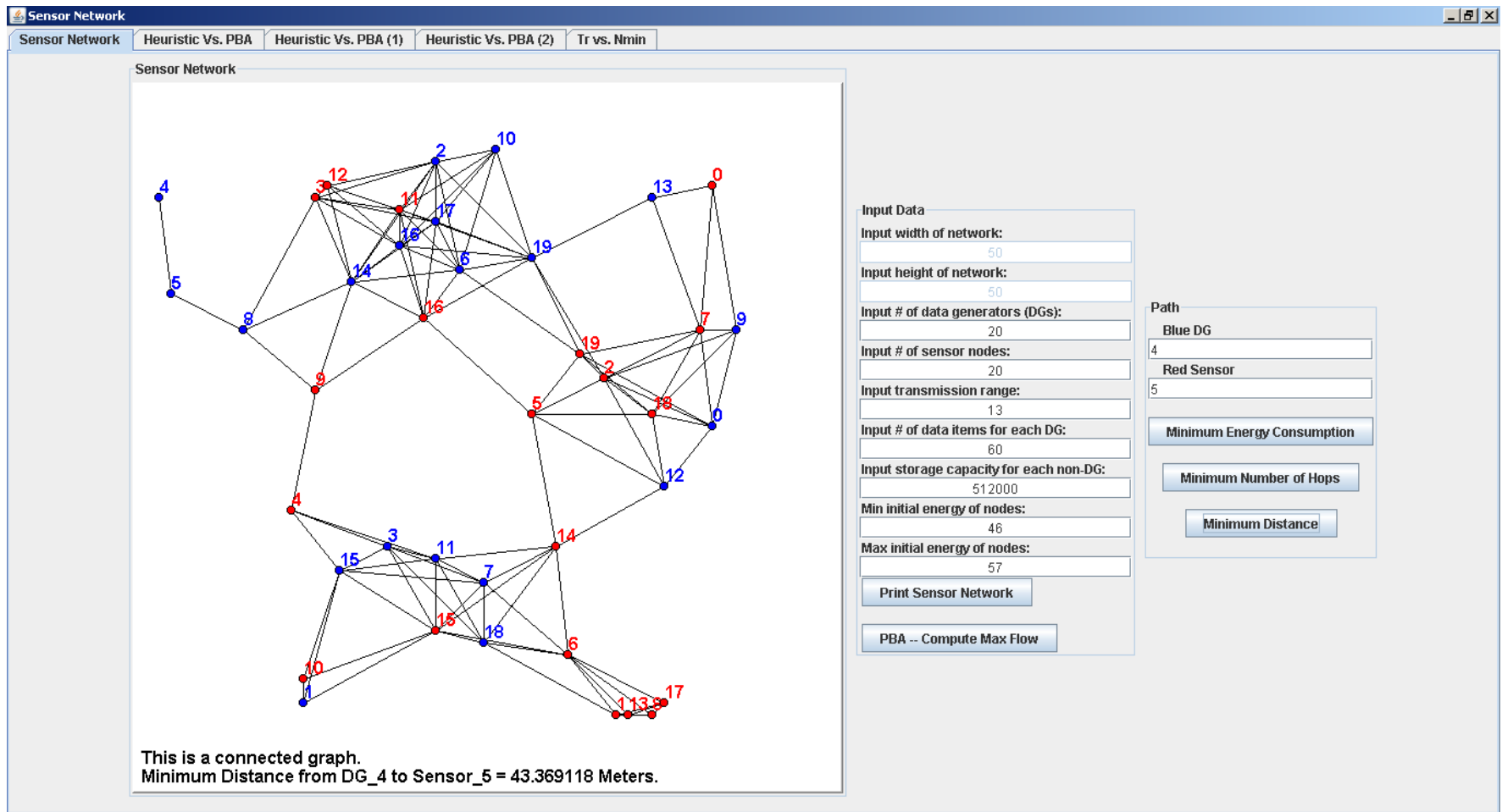
5 Hops



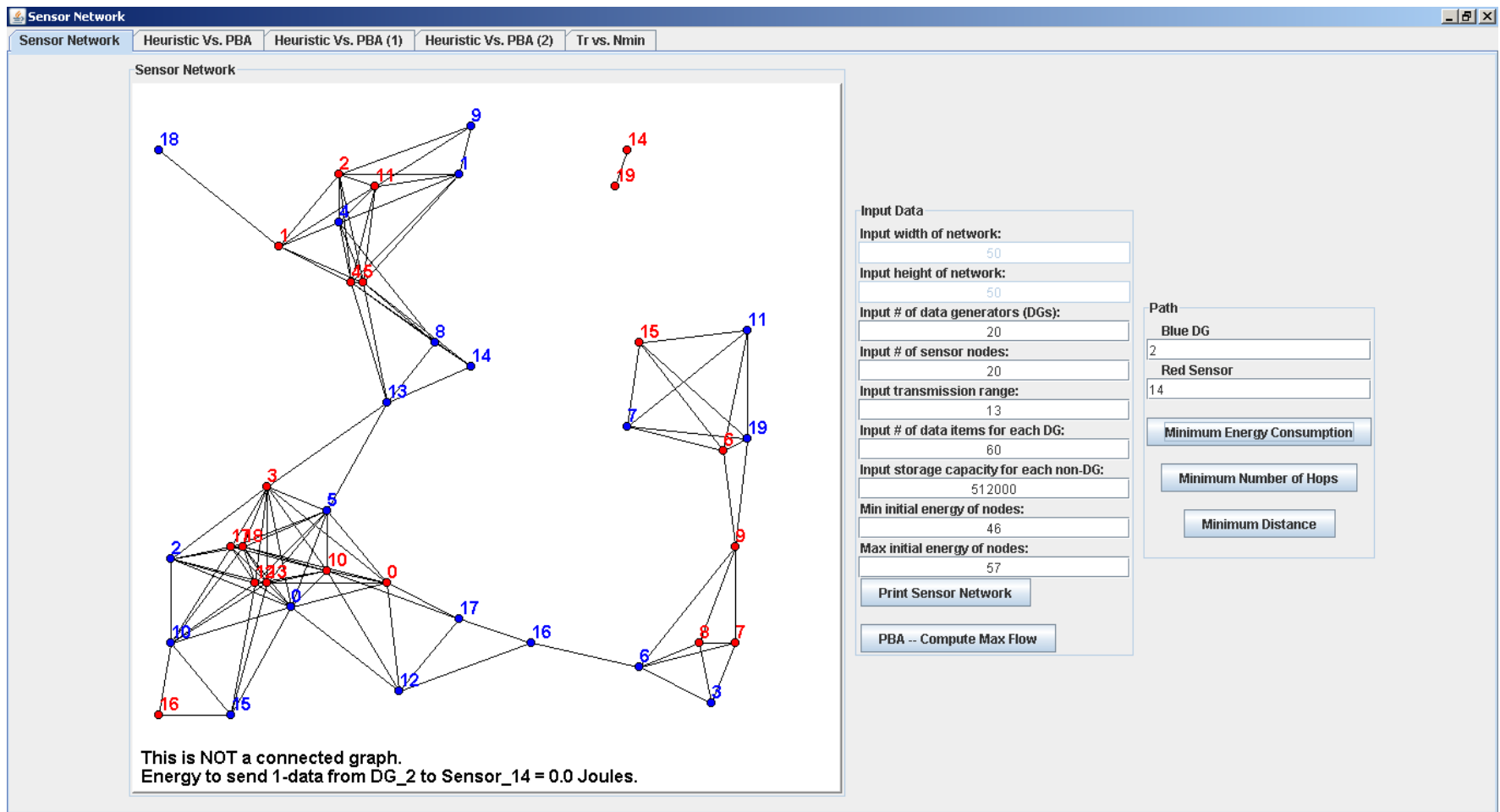
Minimum Distance

Blue DG 4 to Red Sensor Node 5

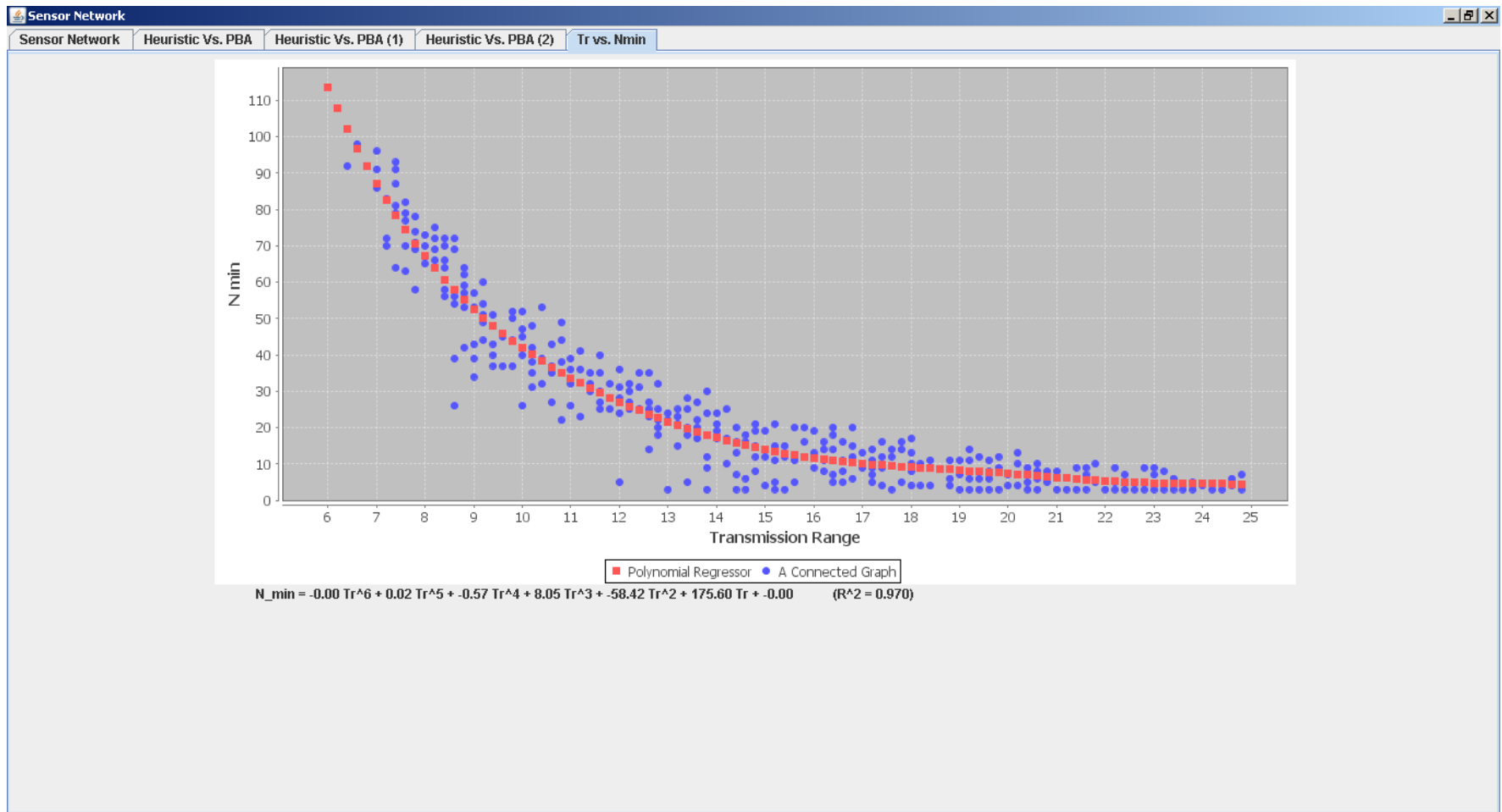
43.369118 Meters



Min Energy, Hops & Distance all error to 0 between **NONCONNECTED** DG to Sensor Node



Transmission Range vs N_{\min}



Theoretical Relationship

- Similar to exponential decay or a polynomial regression

$F(Tr)$ = the function reflecting the minimum number of nodes

Tr = the transmission range

F_0 = a constant

r = decay rate

$$F(Tr) = F_0 \cdot e^{r \cdot Tr}$$

Using the points (15, 15) and (8, 65) off the plot

$$r = \frac{\ln \frac{y_1}{y_2}}{x_1 - x_2} = -0.2159$$

which results in constant $F_0 = 382.43$ to produce the approximation:

$$F(Tr) = 382.43 \cdot e^{-0.2159 \cdot Tr}$$

Plot Spread

- Similar to a Poisson distribution which predicts a range of output

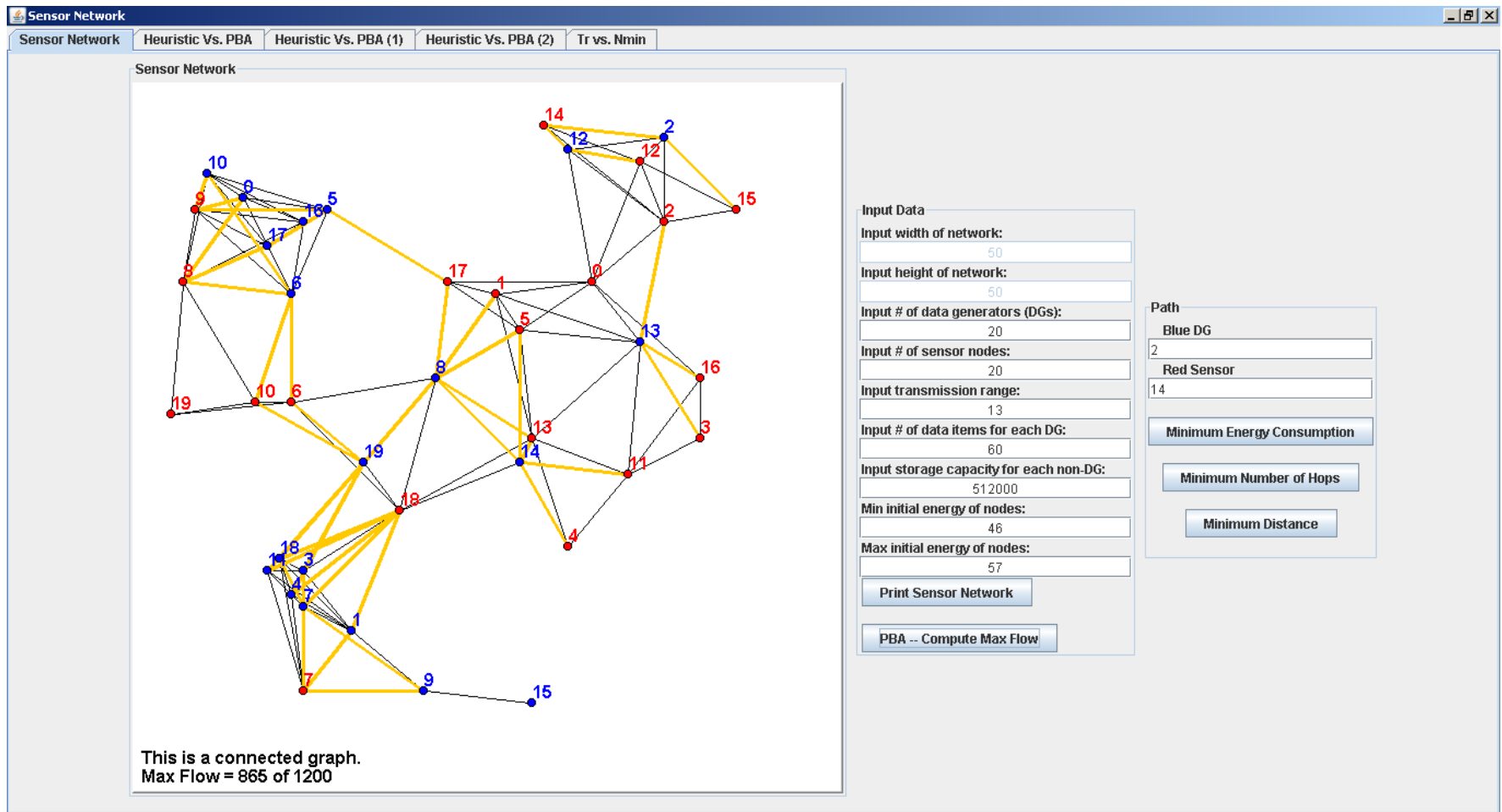
λ = the number of minimum nodes

k = the expected number of minimum nodes

$$\text{Probability} = \frac{\lambda^k}{k! \cdot e^\lambda}$$

- Transmission range of 20 results in $\lambda = 5$
- Expected result of 4 and 5 are 17.6% likely
- Expected result of 6 is 14.6%
- $17.6 + 17.6 + 14.6$ indicates just under 50% of the results should be right around 5

Maximum Flow Priority Based Algorithm



Priority Based Algorithm

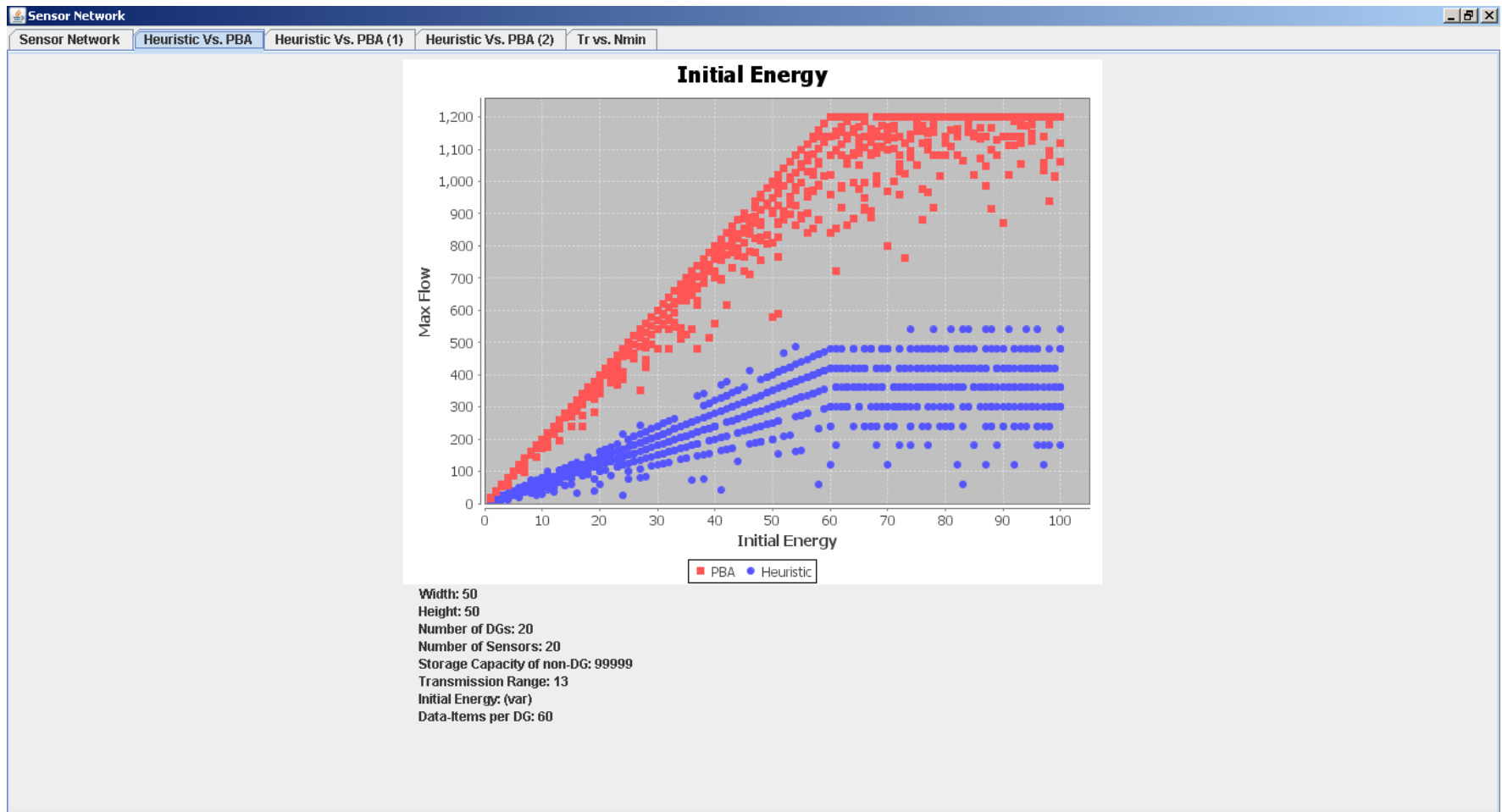
- Implemented using Edmonds-Karp algorithm
- Offload maximum number of data items from the highest priority data generator
- Continue to the second highest priority data generator and descending down until completed

Heuristic Algorithm

- Offload data in descending order from highest to lowest priority similar to the priority based algorithm
- Path dictated by closest distance
- Algorithm often cut short when there are no longer any adequate nodes to offload data to

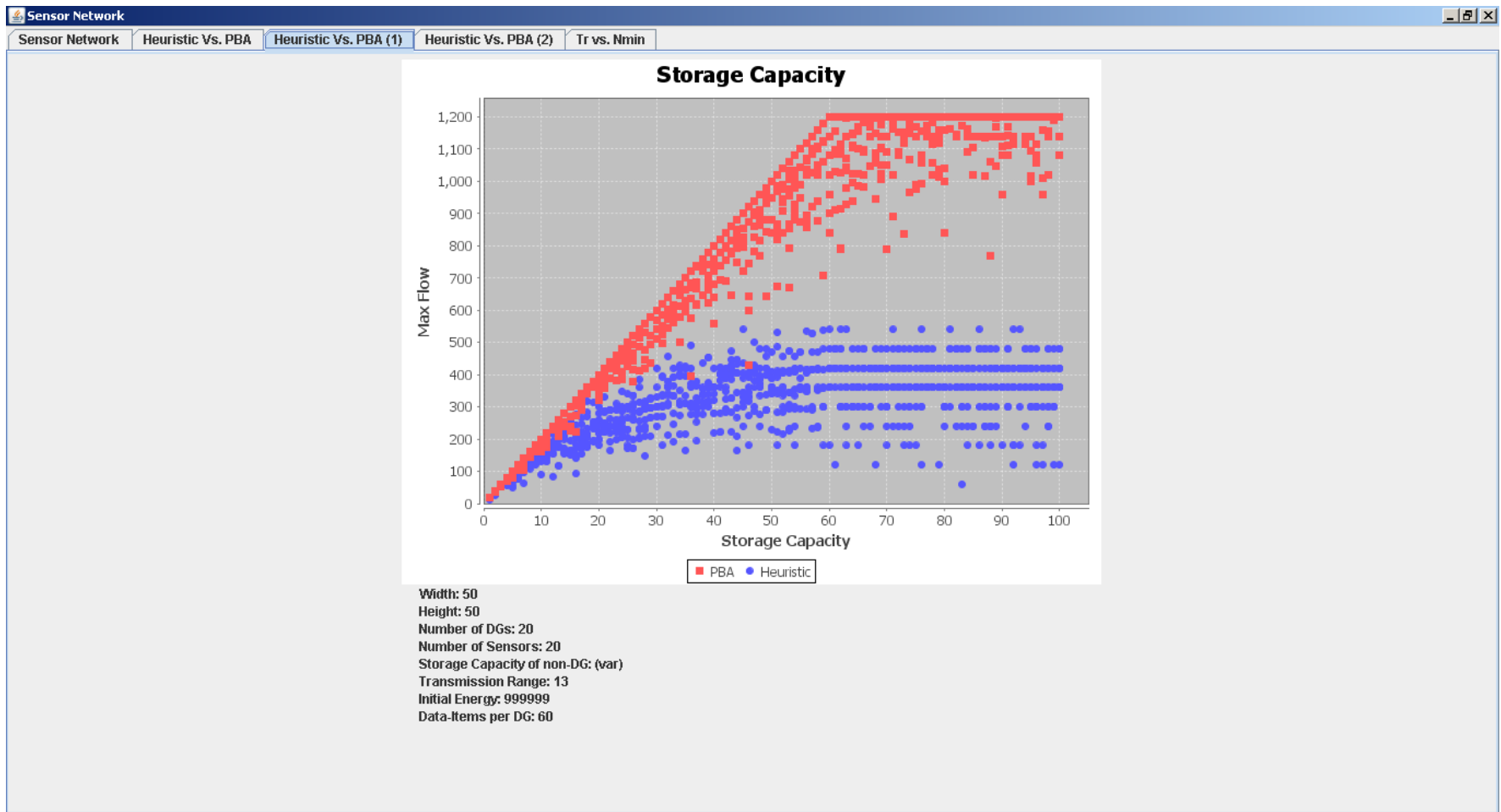
Heuristic Algorithm vs PBA Initial Energy

- Heuristics equals PBA if energy to transfer data is 0



Heuristic Algorithm vs PBA Storage Capacity

- Heuristics equals PBA if energy to transfer data is 0



Heuristic Algorithm vs PBA Data Items

- Heuristics equals PBA if energy to transfer data is 0

