Repeat midterm examination Parallel Algorithms (WISM 459).

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Each of the four questions is worth 10 points. Total time 60 minutes.

1. What is BSP benchmarking?

2. Let $\mathbf{x}$ be a given vector of length n, which is distributed by the cyclic distribution over p processors, with $n \bmod p = 0$. Give an efficient BSP algorithm for processor $P(s)$ (in the notation we learned) for the computation of the product $x_0 \cdot x_1 \cdots x_{n-1}$. On output, every processor has to know the result. Analyse the BSP cost.

3. Let p, n, k be powers of two, with $p \leq n$ and $k \leq n$. Define a permutation σ by $\sigma(i) = (i + k) \bmod n$, for $0 \leq i < n$. What is the exact communication cost of permuting a block distributed vector $\mathbf{x}$ by σ, i.e., assigning $y_{\sigma(i)} = x_i$? The length of the input and output vectors is n. The number of processors is p.

4. Let $\mathbf{x}$ be an array of odd length $n = 2k + 1$ containing numerical values x_i. Assume that all values are different. We want to find the *median* of the values, i.e., the array value x_j such that k array values are higher than x_j, and k are lower. Our aim is to do this in parallel, using the block distribution. On output, every processor has to know the median. Give an efficient BSP algorithm for processor $P(s)$ for the median computation. Analyse the BSP cost; if necessary, make additional simplifying assumptions in your analysis.