Question 1

Let $A$ be an $n \times n$ matrix and $x$ be a column vector of length $n$. Write the following parallel algorithms for the matrix-vector multiplication $Ax = y$.

1. CRCW PRAM with $n$ processors
2. EREW PRAM with $n$ processors
3. 2-dimensional mesh $M_{n,n}$, initialized such that each processor stores a single value from $A$, and processors in the top row stores the vector $x$. More specifically,
   
   \[ P_{i,j}.A = A_{i,j}, \quad P_{1,j}.x = x_j, \quad 1 \leq i, j \leq n \]

Discuss whether your algorithms are cost order optimal, assuming that $W^*(n) = \theta(n^2)$.

Note: Be very careful with the syntax of your pseudo-codes. Clearly identify inputs, outputs, ranges, and parallel assignments.