When the array to be sorted has length n, where $n = 2^k$, for some nonnegative integer k, the recurrence relation for the number of comparisons performed by algorithm Mergesort is $a_n = 2a_{n/2} + n - 1$, with the initial condition $a_1 = 0$. Solving by the telescoping method, we get

$$\begin{aligned}
a_n &= 2a_{n/2} + n - 1 \\
&= 2[2a_{n/4} + (n/2) - 1] + n - 1 \\
&= 2^2 a_{n/2^2} + (n-2) + (n-1) \\
&= 2^2[2a_{n/2^3} + (n/2^2) - 1] + (n-2) + (n-1) \\
&= 2^3 a_{n/2^3} + (n-2^2) + (n-2) + (n-1) \\
&\vdots \\
&= 2^k a_{n/2^k} + (n - 2^{k-1}) + \cdots + (n - 2^0) \\
&= (2^k)0 + \sum_{i=0}^{k-1} n - 2^i \\
&= \left(n \sum_{i=0}^{k-1} 1 \right) - \left(\sum_{i=0}^{k-1} 2^i \right) \\
&= nk - (2^k - 1) \\
&= n \log_2 n - n + 1 \\
&= O(n \log n).
\end{aligned}$$