Step-1

We have given that the proof of $(AB)C = A(BC)$.

We use the column vectors $b_1, b_2, ..., b_n$ of B.

Let $B = [b_1, b_2, ..., b_n]$ and $C = c = [c_1, c_2, ..., c_n]^T$,then

$AB = [Ab_1, Ab_2, ..., Ab_n]^T$ and $Bc = [c_1 b_1 + ... + c_n b_n]$

And then $(AB)c = c_1 Ab_1 + ... + c_n Ab_n$

$= A(c_1 b_1 + ... + c_n b_n)$
$= A(Bc)$

Step-2

The same is true for all other Elements (entries) of C.

Therefore $(AB)C = A(BC)$.