# Learning outcome 3 – questions

1. **Explain RowHammer and its potential solutions based on published papers on InfoEduka.**

-RowHammer is problem in DRAM, which is prime(and perhaps the first) example of how a circuit-level failure mechanism can cause a practical and widespread system security vulnerability. Rowhammer, as it is now popularly referred to, is the phenomenon that repeatedly accessing a row in a modern DRAM chip causes bit flips in physically-adjacent rows at consistently predictable bit locations. It is caused by a hardware failure mechanism called DRAM disturbance errors, which is a manifestation of circuit-level cell-to-cell interference in a scaled memory technology. Solution- Low-cost solution, Probabilistic Adjacent Row Activation, which provides a strong and configurable reliability and security guarantee; a solution whose variants are being adopted by DRAM manufacturers and memory controller designers. The first six solutions are: 1) manufacturing better DRAM chips that are not vulnerable, 2) using (strong) error correcting codes (ECC) to correct RowHammer-induced errors, 3) increasing the refresh rate for all of memory, 4) statically remapping/retiring RowHammer-prone cells via a one-time post-manufacturing analysis, 5) dynamically remapping/retiring RowHammer-prone cells during system operation, 6) accurately identifying hammered rows during runtime and refreshing their neighbors. Which types of memory (memory technologies) are hit by RowHammer attacks?

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Flash memory (NAND), SSDs, RRAM (Resistive RAM), STT-MRAM (Spin Transfer Torque Magnetoresistive RAM) and DRAM (Dynamic RAM).

1. **Why do we consider RowHammer to be a big problem for computer security?**

DRAM chips are an important part of most electronic devices, including those that are essential to computers. We consider RowHammer to be a big problem for computer security because by reading the same address in DRAM it is possible to corrupt data in nearby addresses. Activating the same row in DRAM corrupts data in nearby rows. As such, we cannot allow for the contents inside the memory to be corrupted and/or modified in any unintentional way.

1. **Explain the connection between RowHammer, its potential solutions and energy usage.**

The root cause of DRAM disturbance errors as voltage fluctuations on an internal wire. To access a cell within a particular row, the row’s wordline must be enabled by raising its voltage. such voltage fluctuations on a row’s wordline have a disturbance effect on nearby rows, inducing some of their cells to leak charge. However, frequent refreshes also degrade performance and energy-efficiency. Today’s modules already spend 1.4–4.5% of their time just performing refreshes. This number would increase to 11.0–35.0% if the refresh interval is shortened to 8.2ms, which is required by A20. Every single proposed solution, except for PARA, aren't very desirable because they come at a significant cost of performance and most importantly, higher energy consumption.