Codes for fast write and read processes in multi-level NVMs

Evyatar Hemo
Yuval Cassuto

Department of Electrical Engineering – Technion

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Multi Level NVM

2-Level Cell

More capacity

More precision
↓
Less speed

Multi-Level Cell

0 1 2 3 4 5 6 7
We want to write the following values to a 8-level NVM using the breadth-first process:

- 7
- 0
- 2
- 3
- 3
- 2

Write time is proportional to the number of different levels occupied.
Fast write process – Fixed and CNL models

- Fewer occupied levels → Faster write
- Can be achieved by using only \( \omega \) Fixed levels out of \( q \)
- For example for \( q=8 \) and \( \omega=4 \) we get

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
</table>

Valid levels

Invalid levels

- A legitimate codeword in the Fixed model:

| 1 | 0 | 2 | 3 | 3 | 2 |

- In the CNL model we can: Fixed \( \omega \) → Any \( \omega \)
- For example, for \( q=8 \) and \( \omega=4 \) a legitimate CNL codeword is also:

| 7 | 7 | 2 | 4 | 3 | 2 |