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# Supplying KGD: The CellularRAM™ Approach

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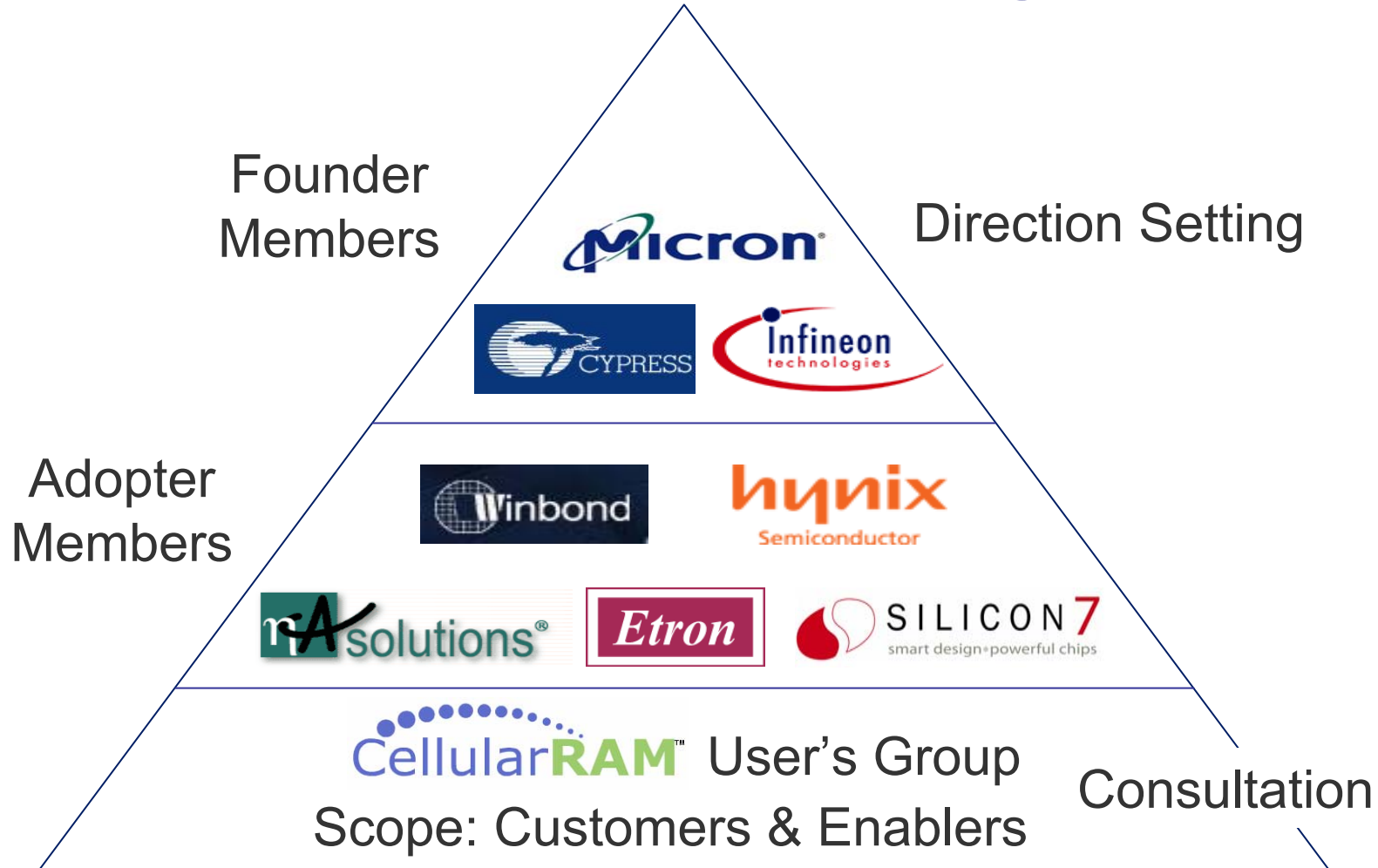
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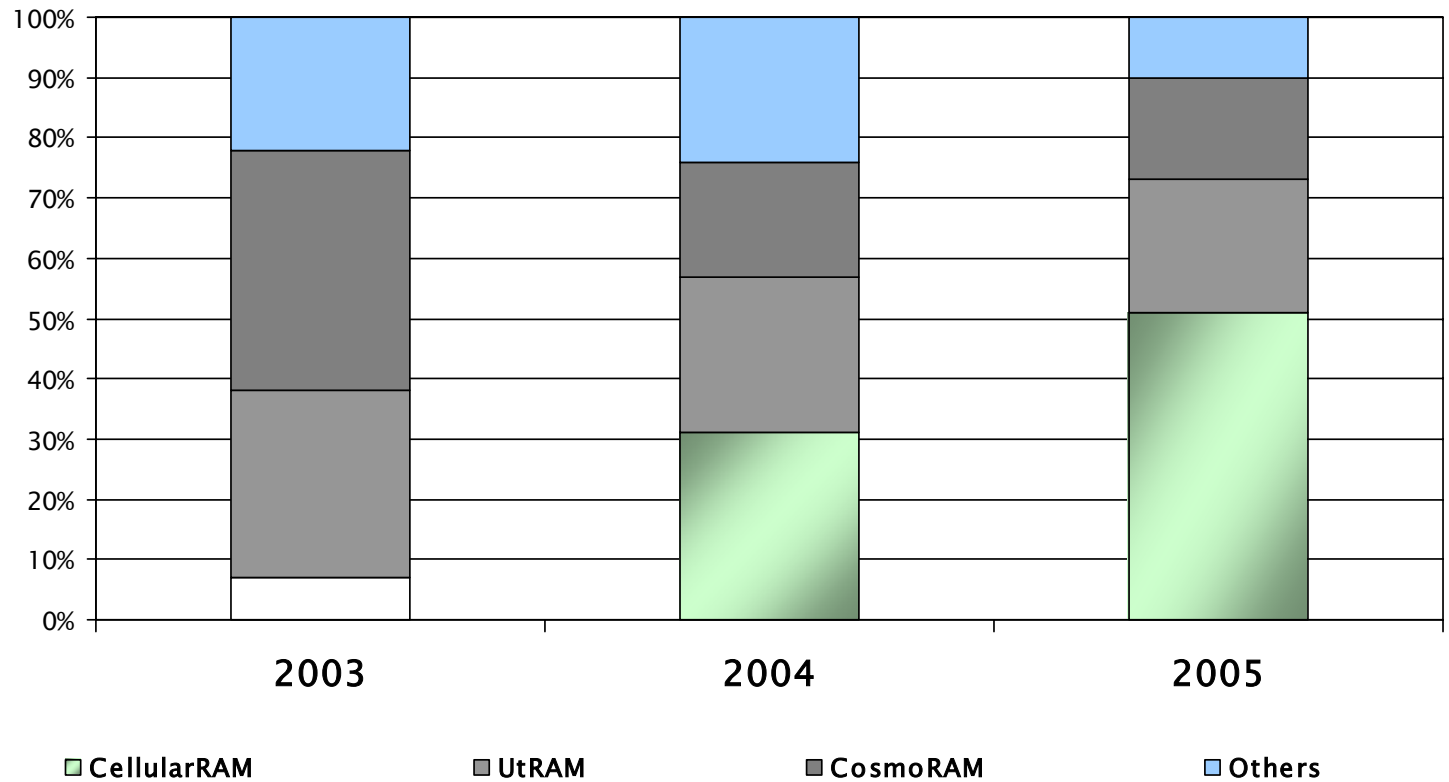
# The CellularRAM™ Workgroup

- Objective: To define a common specification for PSRAM
  - Provide customers with multiple sources of supply
  - Provide vendors with an expanded market
- Common activities
  - Product definition
  - Joint promotion
  - Sample exchanges

# The CellularRAM Workgroup



# CellularRAM Memory – A Growing Market



Source: CRWG MKTG, Gartner, ISupply, Semico

# What is PSRAM?

- Pseudo-Static RAM
  - SRAM/NOR Flash Interface
    - Broadside address
    - Async and burst operation
  - DRAM memory cell for high density
    - Hidden refresh
  - Low-power architecture and features
    - Ideal for wireless applications

Result: A product that is ideal for stacking with NOR Flash in MCPs for cell phones; i.e., KGD!

# KGD “Group” Supply Challenges

- Initial specifications included all the usual items
  - Functional descriptions
  - Timing parameters and diagrams
  - Parametric values

Each vendor had their own data sheet.  
But it was not enough for common KGD!

# KGD “Group” Supply Challenges

- Data sheet differences
- Pad location
- Parametric measurement
- Functional differences

# Data Sheet Differences

- Originally, each vendor had their own data sheet
  - Exchanged data sheets for comments
  - Some differences always remained
- Now, the CellularRAM Workgroup generates a “workgroup data sheet”
  - Serves as a reference document for all vendors
  - When approved, it’s posted as reference document for customers

# Pad Locations

- Initial products specified package ball assignments, but not pad sequence
- CR1.5 introduced common pad sequence
  - Technology node and architecture decisions will cause die size variations among vendors, but pad sequence is the same

# Parametric Measurements

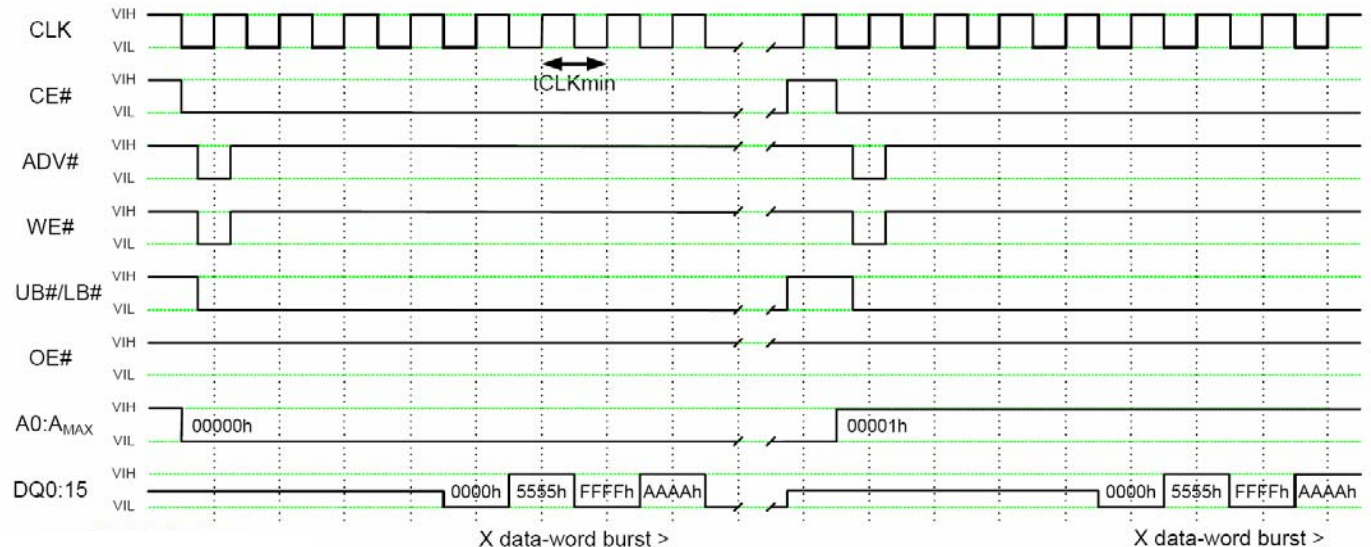
- Sample exchanges revealed variations in active current measurement techniques
- Measurement spec developed as reference for members and customers
  - Defined device configuration, timings, and test pattern

# Icc Measurement Spec Example

## CellularRAM™ Icc3W - Continuous Burst WRITE

Measurement Conditions	Pattern Description
<p><u>Register Settings</u>            CRAM 1.5: BCR=81D1Fh RCR=00014h – Synchronous Access Mode, Continuous Burst, Variable LC3, Refresh Disabled            CRAM 1.0: BCR=81D4Fh RCR=00074h</p> <p><u>Timing Requirements</u>            tCLK min; Terminate and reinitiate burst every X data-words, where X = vendor specific row page length (usually 128 or 256).</p> <p><u>Notes:</u>            OE = DC high (DQ Hi-Z)            CRE = DC low</p>	<p>Pattern cycles through a series of continuous burst write cycles. To avoid row boundary crossings, the number of data-words written (X) is equal to the vendor specific row page length. Writes sequence with a data pattern of: 0000h, 5555h, FFFFh, AAAAh (half DQs toggling per clock cycle).</p> <p>Addresses are held static throughout the X data-word continuous burst once latched at the beginning of the cycle.</p>

Fig 7: Icc3W Timing Diagram



# Functional Differences

- Independent designs always result in some differences
  - Designer interpretation
  - Incomplete specification
  - Off-data sheet/unspecified functionality
- Members working toward exchange of behavioral models and test benches

# Conclusion: Supplying Better KGD

- Lessons learned
  - Start from common specification
    - Make it as complete as possible
  - Minimize physical differences
    - Recognize there will always be some variations
  - Specify test conditions
    - Configuration, timing, patterns affect parametric measurements
- Work that remains
  - Behavioral models for complete functional definition

# Q&A

- Questions?

Thank You