Emerging Memory Product Lifecycle

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NEW MEMORY PRODUCT LIFECYCLE

- Memory Technologies all go through certain steps from concept to mass production. Historical data tells us:
  - There are certain timeline expectations … how long does it take
  - There are certain milestones and technical achievements in a certain order
  - Most technologies fails or are indefinitely delayed before mass production
- This model for development allows us to put ideas and concepts into perspective
  - What are the next steps we need to achieve?
  - What timeframe seems logical
  - Where do different technologies stand on the lifecycle
- We have models on how to accelerate this or save money on this lifecycle

Uses for Model

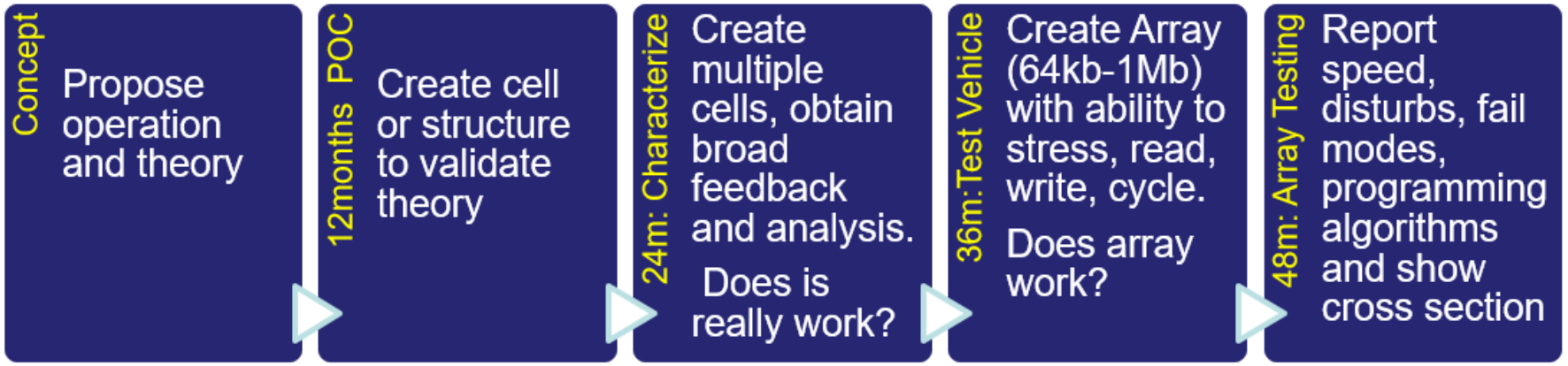
- I have a new technology proposal
  - What are next steps
  - When do I need to look for partners
  - What do I need to do and show to get support from equipment companies, memory companies and application companies
- When can we expect other technologies to mature
  - “Why ramp 3D Xpoint when Nanotubes are just around corner”
  - “Micron will be out a business when MRAM replaces DRAM”
  - Each technology has a logical timeline to maturity

Parts of the Model

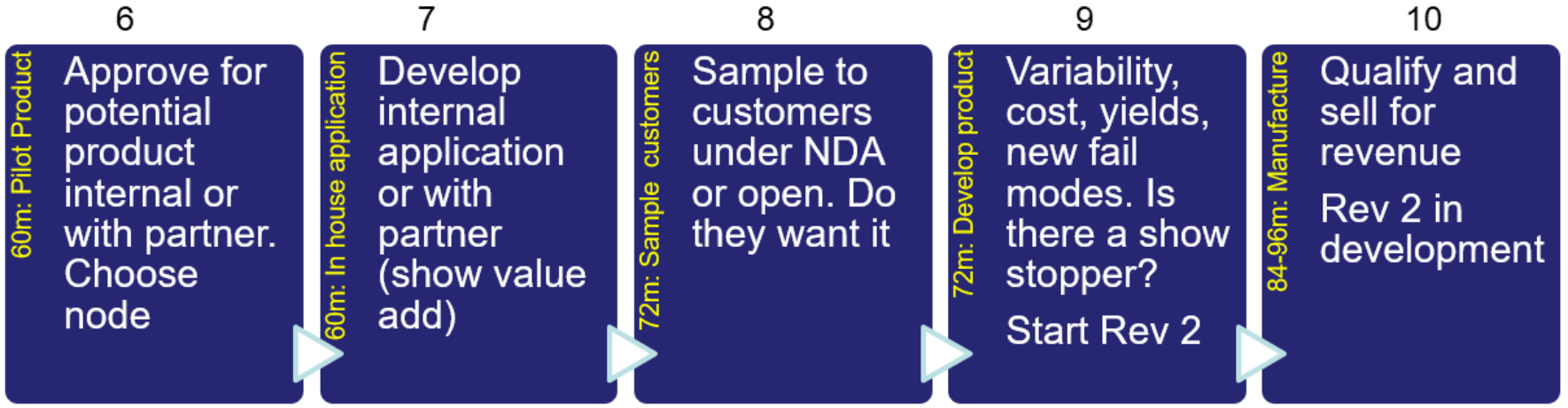
- Two Parts and each part has 5 stages
  - Part 1 is Technical development and demonstration
    - Often open data sharing, lots of publications, learning environment
    - Physical model, test cells, basic operation, first mini-array, and full checkout of Array
    - 4+ years
    - Stage 1-5 1.1 to 1.5
  - Part 2 is Product development
    - Only 10% of technologies make it to this area
    - Often stealth or closed environment. IP protected
    - Business model, partnerships, ROI, Product and application design and development
    - Ends with full product selling to public
    - Stage 6-10, 2.1 to 2.5

Memory Product Lifecycle

Part 1
(Stage 1-5)



Part 2
(Stage 6-10)



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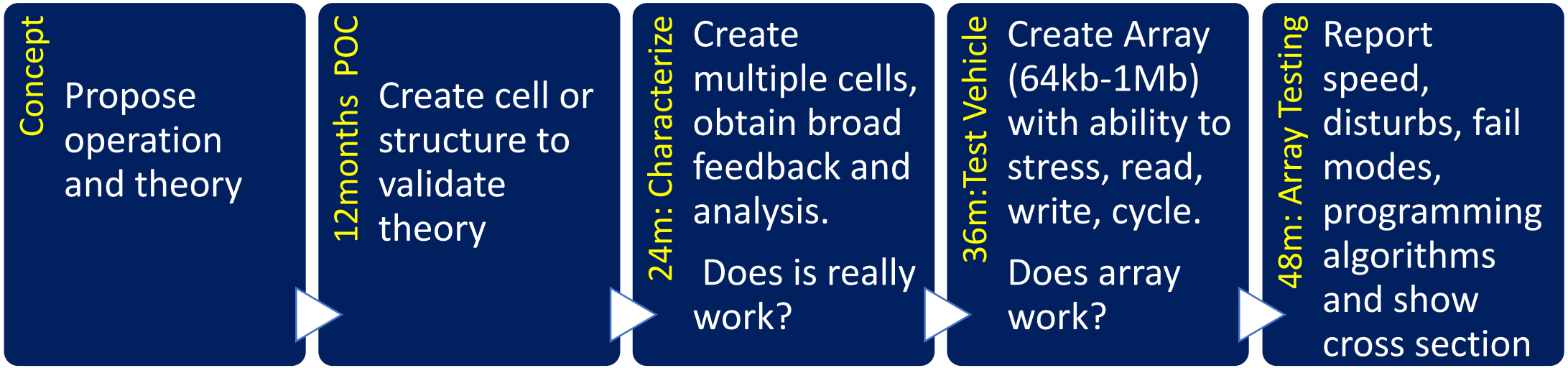
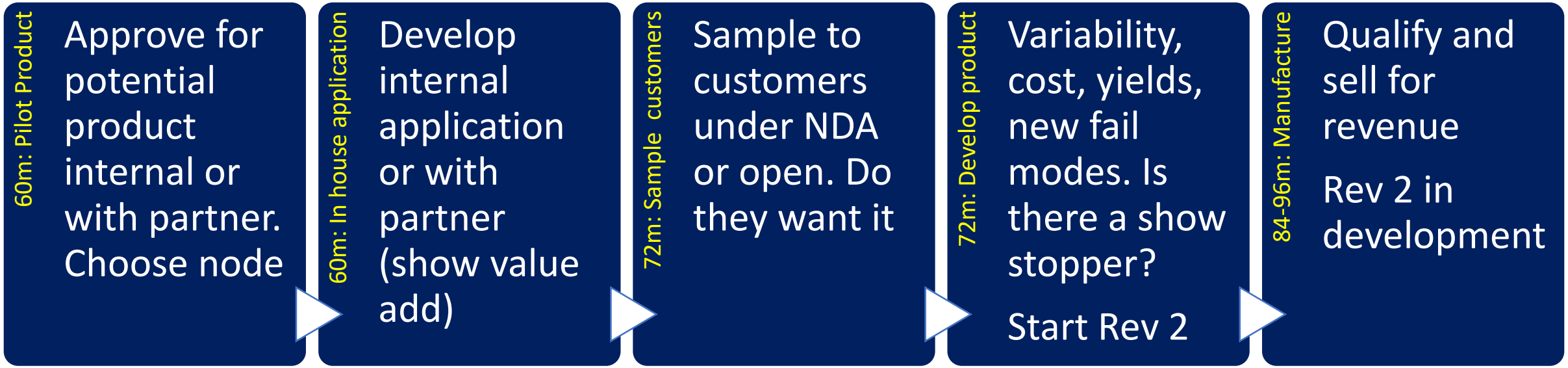
Product Lifecycle for Memory
Part 1: Technical Proof/Open Communication



End Result: a working technology fully demonstrated and checked out

- Documented Summary: " A Novel xRAM technology built in 90nm Lithography "
- Doesn't need to be on leading edge lithography, but should be capable
- With pictures/TEMs/SEMs (4-5 years after concept)

Product Lifecycle for Memory Part 2: "We are going to build a product"



- 7-8 Years from concept assuming no restarts or resource limitations from concept to revenue
- Usually performed in a stealth mode. Presentations disappear (3DXP example)
- Next announcement is samples or early production (MRAM/Xpoint)

Problem with Hype/New tech

- People want to jump to page two before completing page one. Fine to speed flow, but we know that 90% of technology concepts don't make it to products
- It rarely makes sense to be stealth in part one
  - You want to show research, You need funding
  - The work is either patented or is not novel
  - You need to get feedback and advice and investors
- Open and closed companies follow this (FinFet, 3D NAND, PCM, MRAM, ReRAM, NRAM, etc)

- RECOMMENDATION: Complete all stages of part 1 in detail to be efficient in development
- RECOMMENDATION: Evaluate all technologies and chance for success based on where they are on lifecycle.

Investment and Venture Capital

- Companies/investors will support all phases depending on their goals
  - “place bets” based on Phase 1. They just want to see data
  - Invest to support phase 2, 3. Often many parallel companies invest.
  - Phase 4 is where companies look to control investment and IP.
  - After Phase 5, companies are planning what the mass market revenue is.
- Manage Internal, investor, and external communication differently
  - Mark’s saying: “I strongly support your goal to get additional funding based on optimistic presentations!”
  - Make sure you know real risks and probabilities and that the IP/ownership is controlled with respect to that.
  - Do you want to license, sell operation, grow operations, control technology …. Every technology and person is different.
- I have advised companies on how to invest (iCAP, WDC) and what to look for. Often they have competing or different motives than advisors
  - “we want to control it, even if we don’t think it will work”
  - “we have IP/patent issues that we need to manage”

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Summary

- Assess where we are in the lifecycle
- Assess where we are in time and where we will be in next year or two
- Keep investors posted on where we are, learnings and help needed
- Don’t skip steps. It tends to cause delay and wasted resources on a good technology