

# NAND Characterization

We aim to find your best SSD algorithms

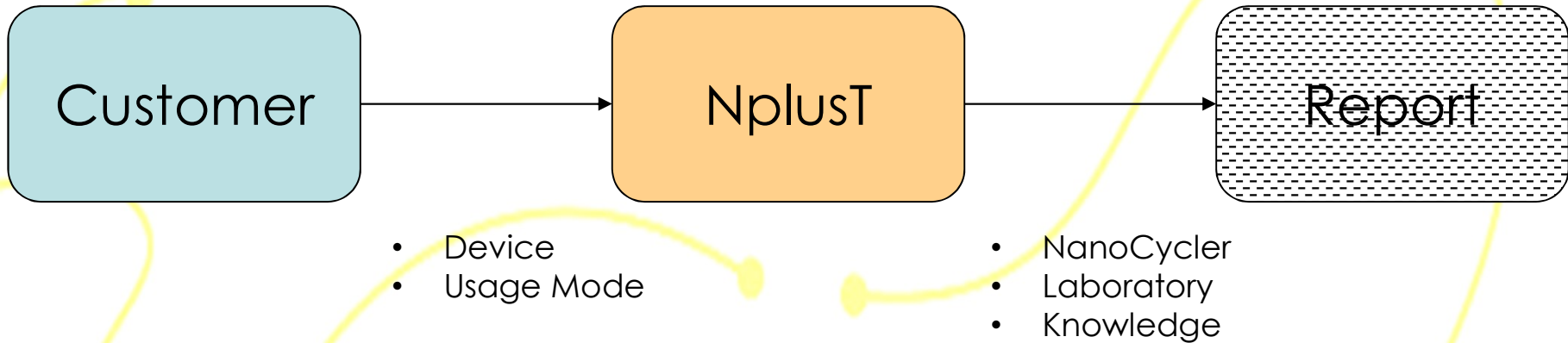
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# Partnering with NplusT

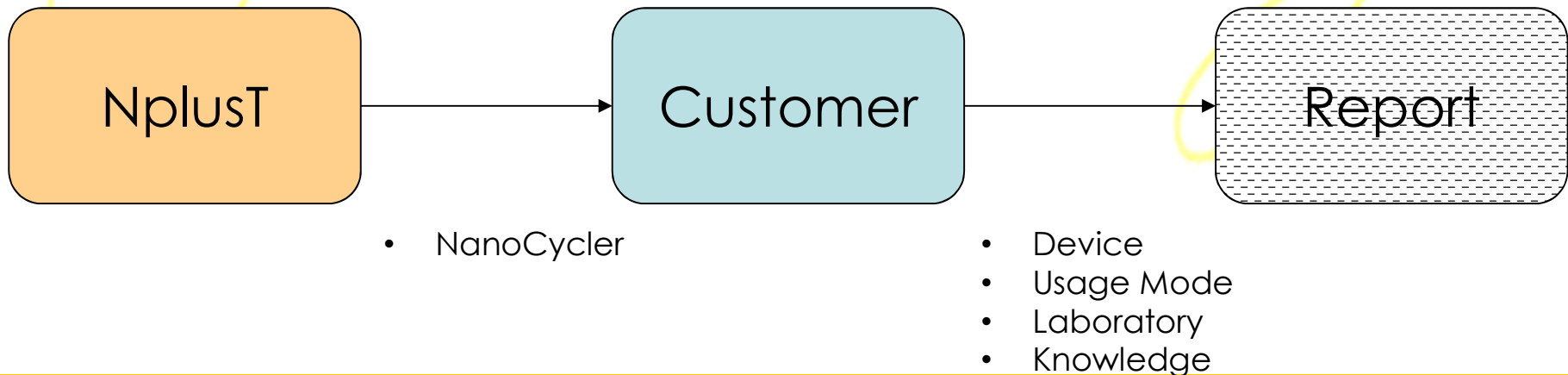
## Model: Characterization Services

*We aim to find your best SSD algorithms*



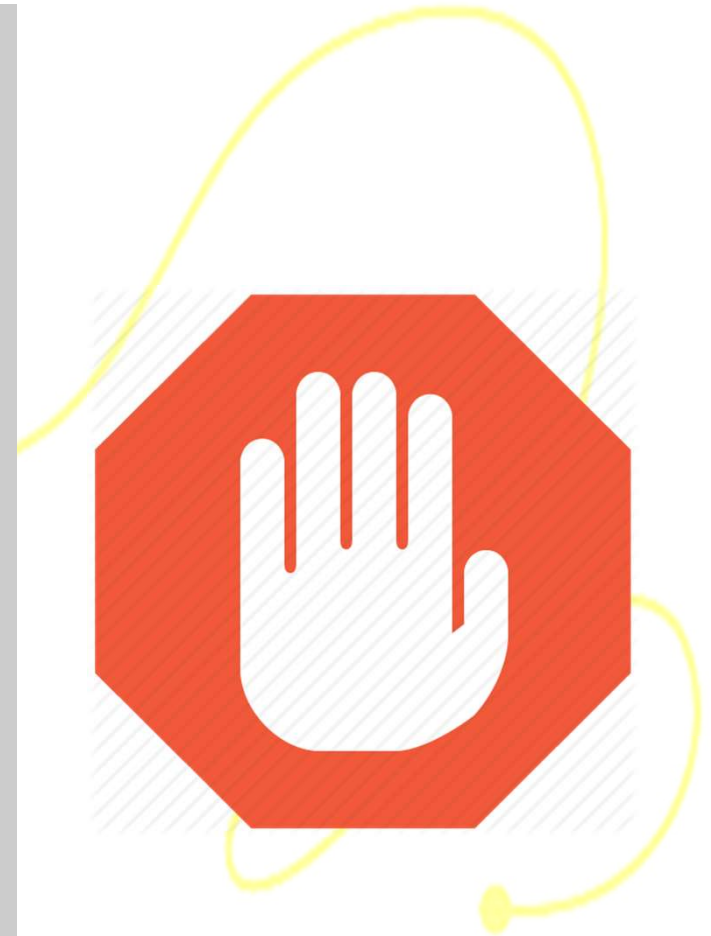
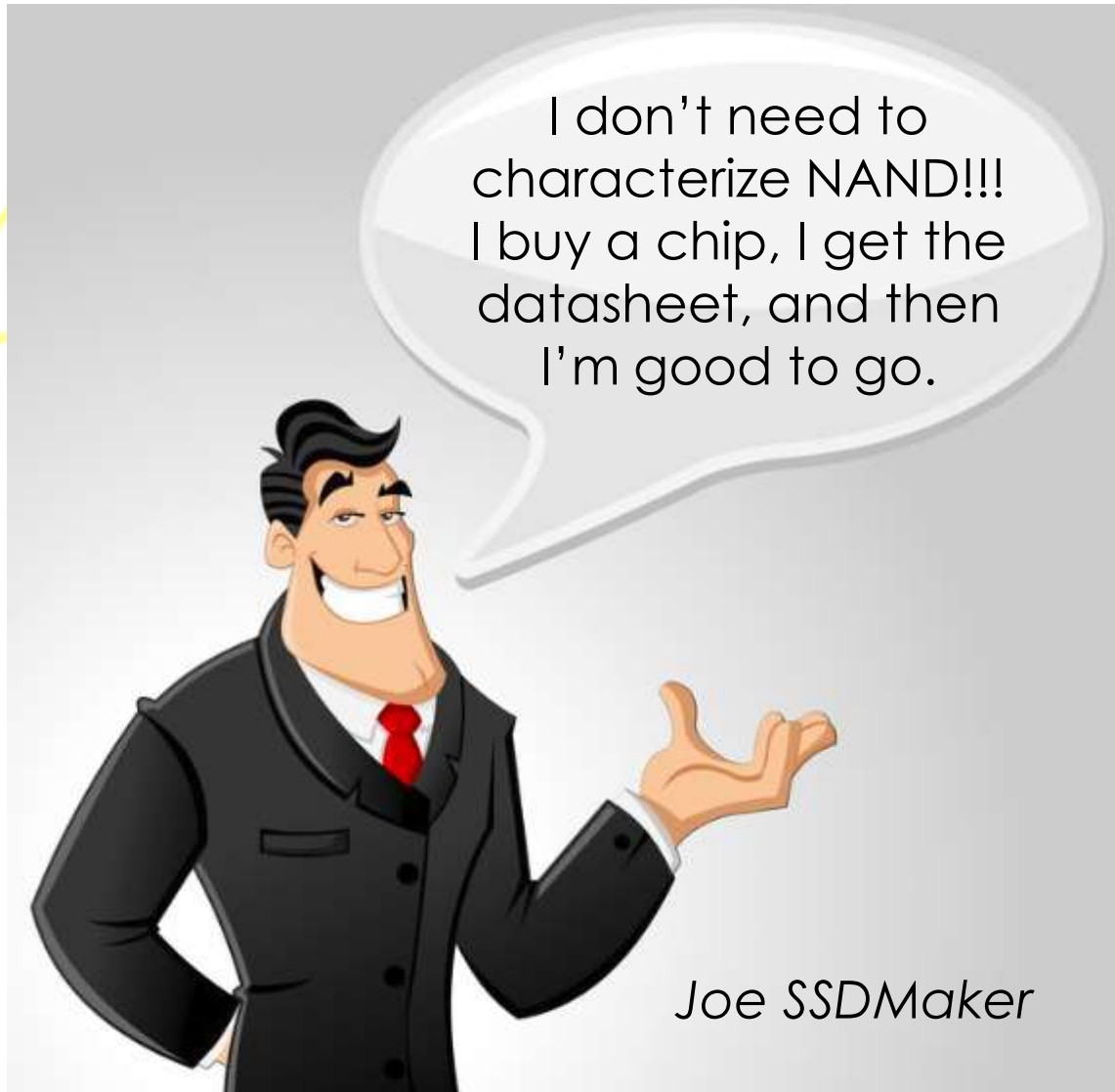
## Model: Characterization Equipment

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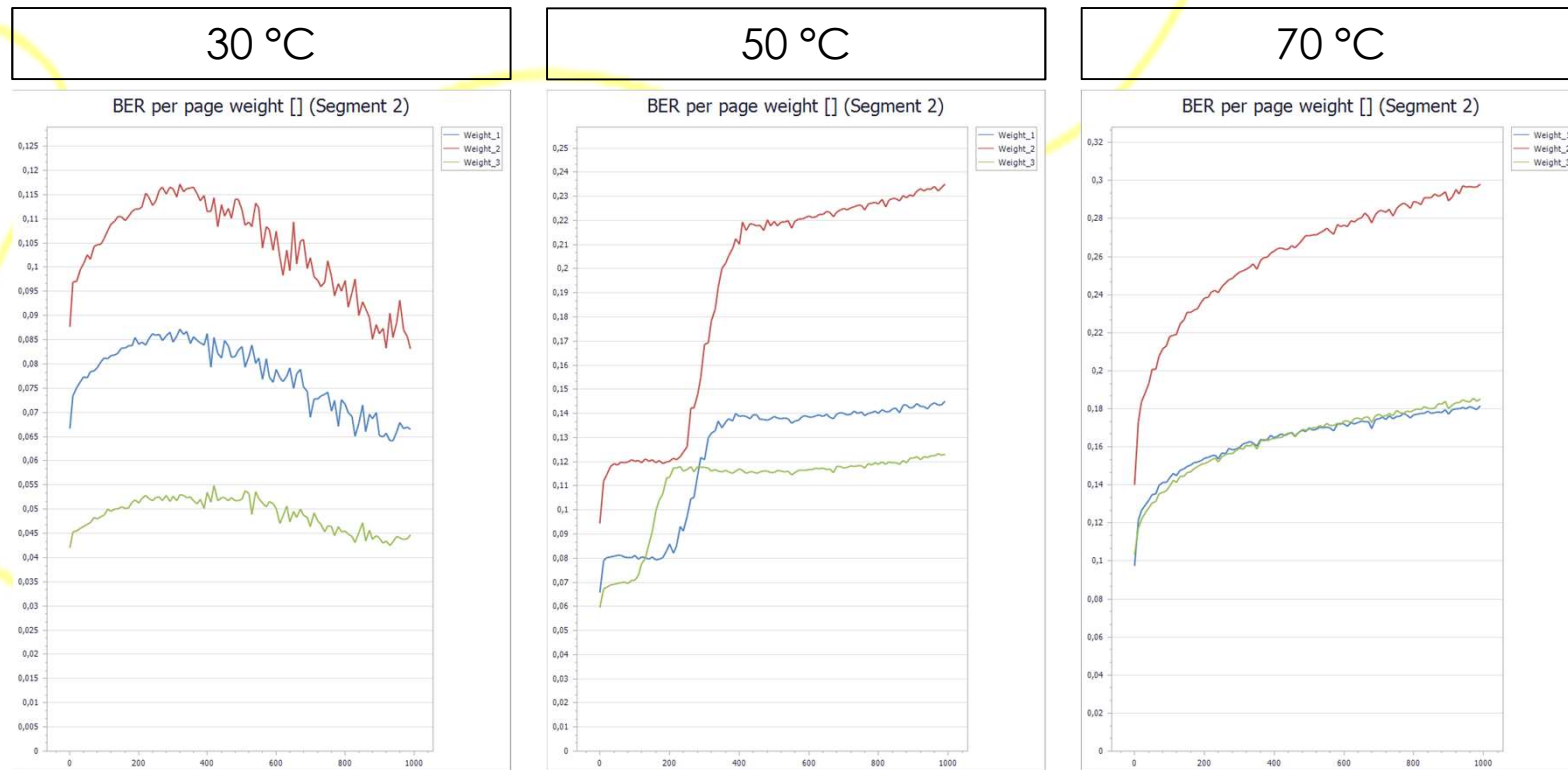
# Why NAND Characterization ??

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# Discovering the NAND

How does the RBER change after programming ?  
Does it depend also on the temperature ?



# Limited Set of Information

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- ❑ Datasheets cover AC/DC/Functional parameters but there are very few details about how to reach the specified reliability
- ❑ Multiple uncovered topics:
  - Ex.: read-retry. Which option should I pick? I test dozens of options but QoS looks horrible !
  - Ex.: Do program and erase suspend operations impact raw BER ?
  - Ex.: How many read operations can run on a block between two erase cycles ?
  - ...

# Flash Memories Are Imperfect

## ❑ NANDs have inherent failure modes

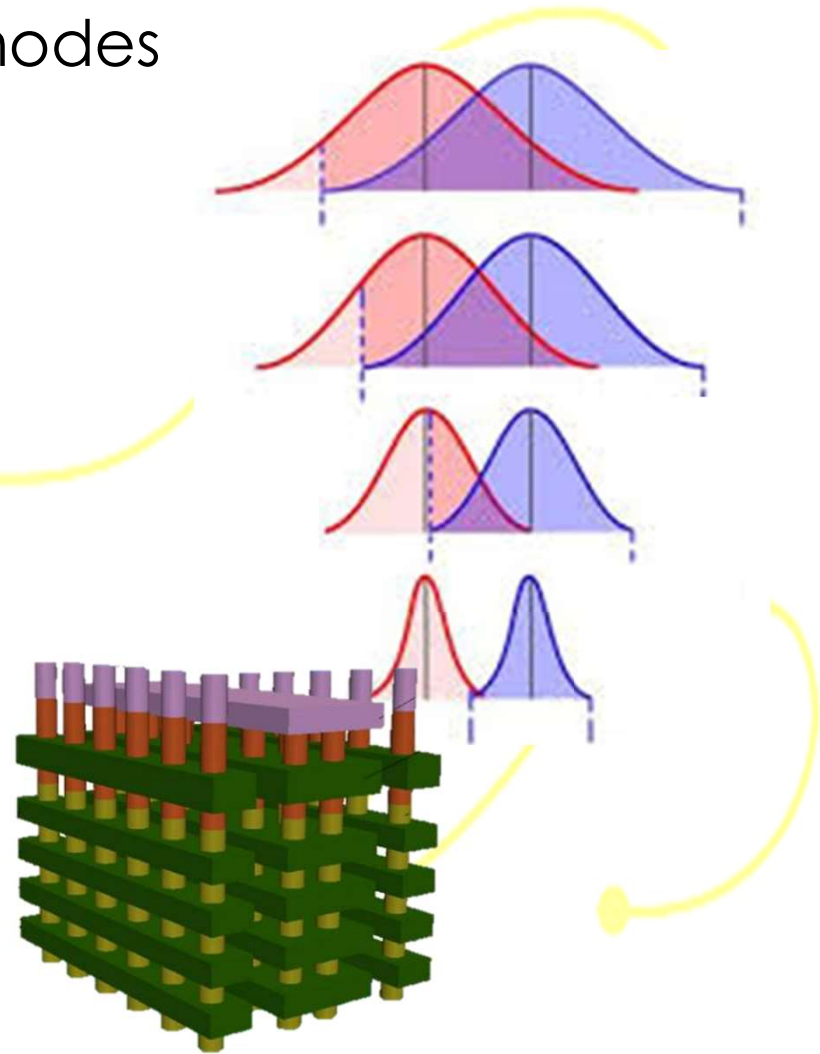
- Read Errors
- Cell Interference
- Read Disturb Effects

## ❑ NANDs wear out during life

- Limited Endurance (P/E Cycles)
- Retention Time
- Number of Read Operations

## ❑ Limits strongly depend on

- Technology
  - SLC/MLC/TLC/QLC
  - 2D/3D
- Usage Mode !



# Compensation Algorithms Needed

- Error Correction
- Read Retry
- Bad Block Management
- Wear Levelling
- ...




In order to achieve the target reliability and performance:

What to compensate ?  
And how ??

# I Need NAND Characterization !!

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Yes, I need to understand better the NAND, I need to characterize it applying my usage mode.

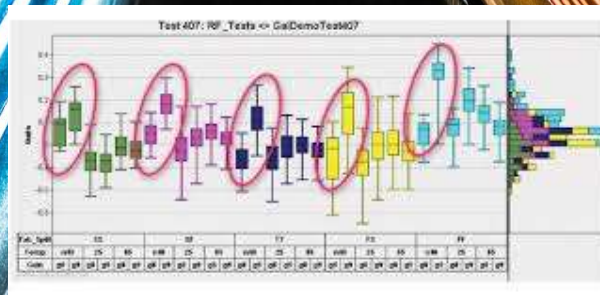
*Joe SSDMaker*



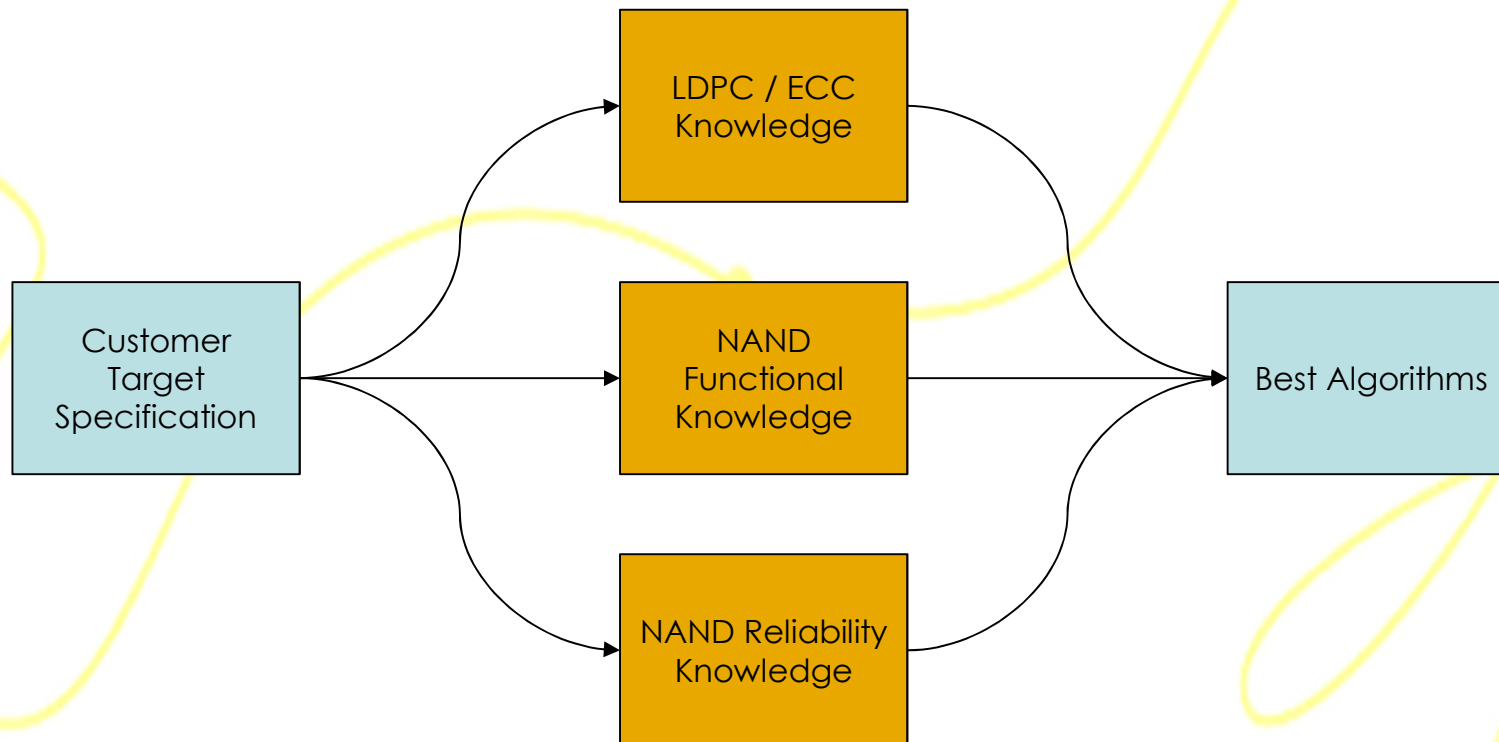


# Characterization

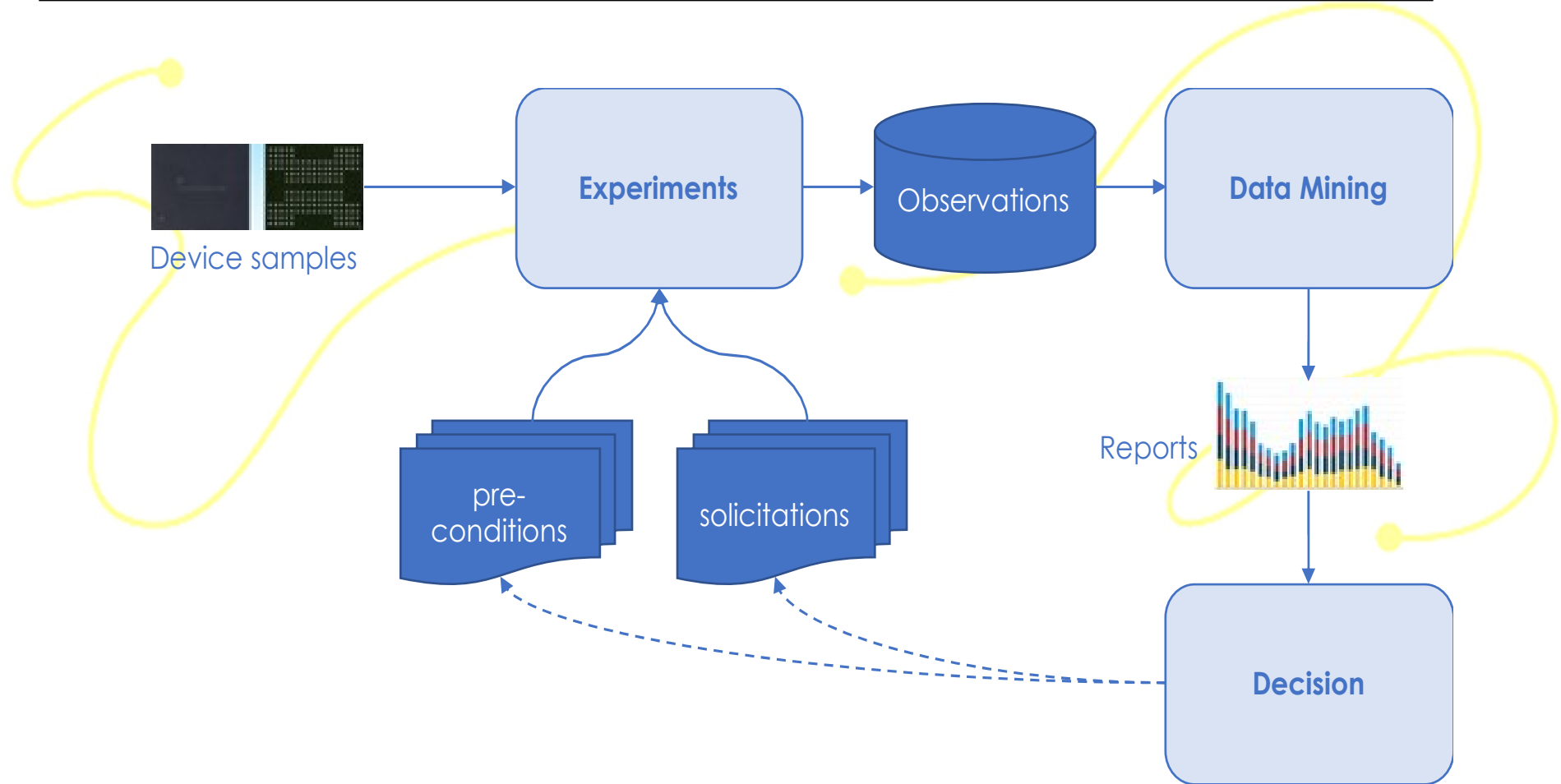
services provided by a skilled team  
of industry experts



# Context of NAND Characterization



# Fully Integrated SSD-NAND Characterization Flow



# Characterization Capabilities

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- ❑ Environment and operational parameters
- ❑ Reliability conditions
- ❑ Read Retry options
- ❑ LDPC and Soft Decoding
- ❑ Suspend operations → SSD QoS
- ❑ **Algorithms for NAND lifetime extension**
- ❑ Miscellaneous

