

Industrielle Speicherlösungen von ATP

Was ist anders an industriellen Speicherlösungen?



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1.0

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Agenda

- Die richtige Wahl treffen
- Limitierungen und Möglichkeiten
- Portfolio Übersicht
- Fragerunde





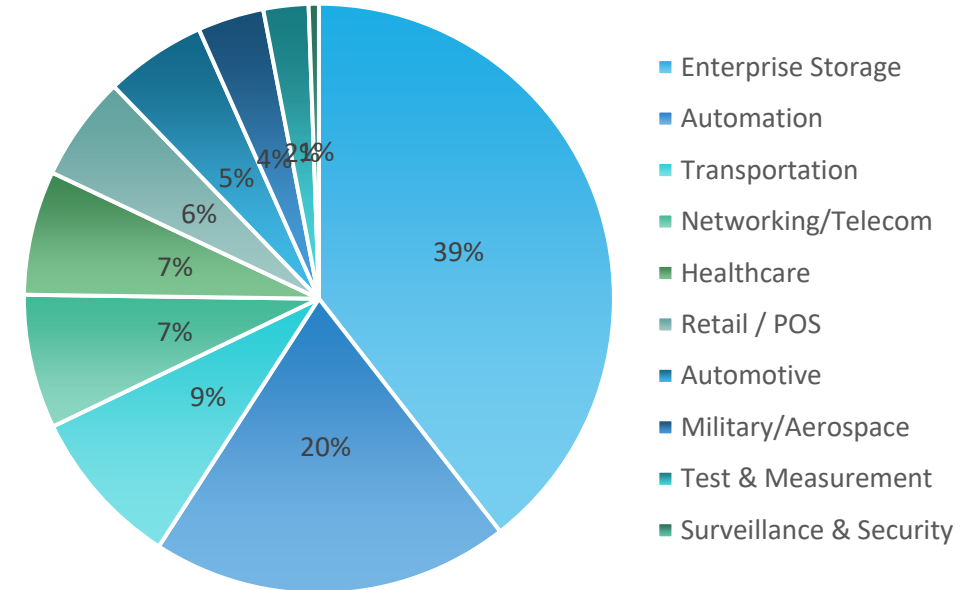
ATP in aller Kürze

Seit 1991 stellt ATP industrielle Speicherlösungen her



A LEED-certified green building, slated for operation in 2025 2H at Ciaotou Science Park In Kaohsiung, Taiwan

Marktsegmente, die ATP bedient:





ATP in Thomas Krenn Systemen

- **ATP Produkte findet man überall dort, wo Kriterien sich von Mainstream-Produkten unterscheiden, bezüglich:**
 - Langzeit-Verfügbarkeit
 - Erweiterten Temperaturbereichen
 - Legacy Formfaktoren
 - Erhöhten Anforderungen an Robustheit und Ausfallsicherheit
 - Gleichmäßiger Performance

Nahezu alle

- DRAM
- Langzeit verfügbar
- DDPM / Qualität

Tower Server

- M.2 NVMe
- Verfügbarkeit
- Ausfallsicherheit

Edge Systeme

- M.2 SATA / mSATA
- Temperaturbereich
- Legacy

Ind. HPC/ACP Server

- M.2 & 2.5" SATA
- Langzeit verfügbar
- Ausfallsicherheit

UNO/MIC IPCs

- mSATA / 2.5" SATA
- Temperaturen
- Legacy

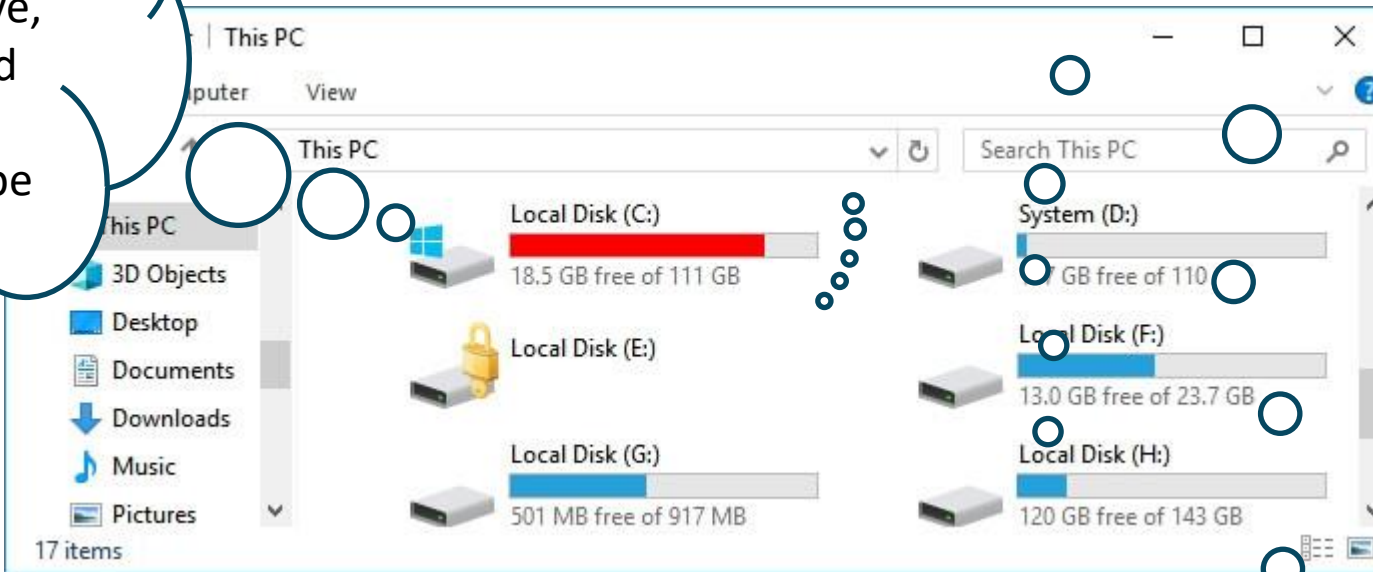




Consumer vs. Embedded Storage

Consumer:

Damn, I need to clean up my drive, why is it packed like this? Next drive will be bigger!



Embedded:

Okay, 16% left, will performance go down now?

If I write total capacity 3x a day, will it fail in my warranty period?

That drive got hot, will throttling kick in?

How can I delete the data so it's not recoverable, ever?

Took me a year to qualify the drive, can I still obtain a new one?



Die Essenzielste Frage für Storage:

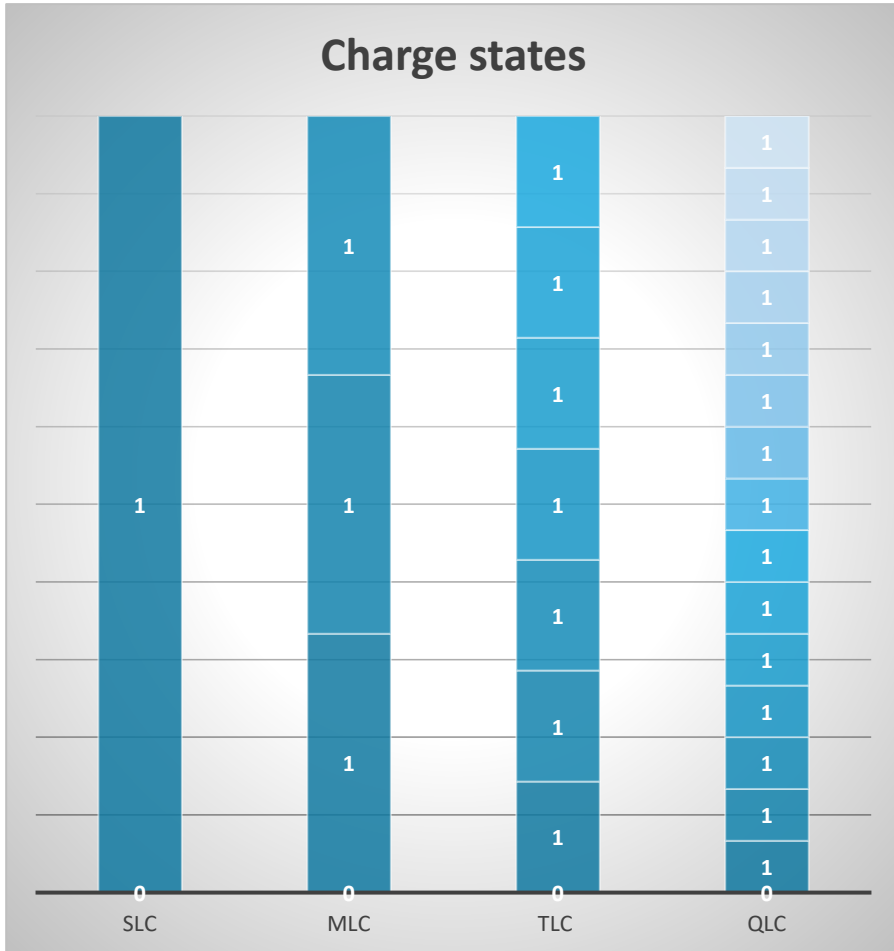
■ Was soll die SSD aushalten, wofür wird sie im System genutzt?

Boot Drive	Datenspeicherung	Datenlogging	Ring Buffer / Cache
<ul style="list-style-type: none">• Endurance ist irrelevant• Temperatur kann wichtig sein• Data retention, wenn das Gerät häufig und lange stromlos ist	<ul style="list-style-type: none">• Endurance sollte dem Datenvolumen in der Lebenszeit entsprechen• Temperatur• Leistung• PowerLoss Protection	<ul style="list-style-type: none">• Endurance• Temperatur• Gleichbleibende Performance über Temperatur und der gesamten Kapazität-entsprechend des Datenaufkommens als Minimum	<ul style="list-style-type: none">• Endurance, gemessen in DWPD• Niedrige Latenz• Performance• %Life Überwachung
MLC / TLC, oder gar QLC	MLC / TLC	TLC / pSLC	pSLC, SLC





Technologien kurz erklärt



- In SLC ist eine Zelle geladen oder nicht, 0 or 1
- In MLC werden zwei Bit gespeichert, wie folgt:
 - 0 / 0 = 0
 - 0 / 1 = 1
 - 1 / 0 = 2
 - 1 / 1 = 3
- Inklusive der Entladung, also 4 Ladezustände
- TLC speichert 3 Bits, also 8 Ladezustände
- QLC hat entsprechend 16 Stati



- Stellen Sie sich eine Zelle wie einen Eimer vor, der von einem Hahn auf ein Level gefüllt wird
- Zwei Faktoren bestimmen den Füllstand:
 - Zeit
 - Druck
- Öffnen Sie einen Hahn tausende Male, verschleißt dieser:
 - Der Füllstand verändert sich über die Zeit
 - Bitfehler treten auf
 - Leichte Varianz wird korrigiert, doch es gibt natürlich Grenzen



Why do all these Technologies exist?

- **Consumers are never happy with prices, ask more capacity for less money**
- **Semiconductor suppliers have several ways to achieve higher density at a lower cost:**
 - Shrink technology, so more dies fit on one wafer
 - Improve yield by modifying the process
 - In case of memory, store more bits per flash cell
- **MLC was just the beginning, technically much worse than SLC**
 - 60-100k P/E cycles vs. 3-8k P/E
- **TLC started with 1500 P/E cycles, but improved.**
 - Today, ATP specifies Micron 176 Layer flash up to 11k
- **QLC starts at 500 P/E cycles**
 - for most embedded applications unsuitable, the reason ATP has no QLC products yet
- **Memory Market is driven by consumers, which ignites innovation and cost-down efforts**
 - The embedded market is significant, too. 90% of CPUs are embedded. But memory capacity is lower overall.
 - Suppliers like Micron and Kioxia maintain hand-picked technologies for 4-5 years, mainly when they have own (embedded) business for these.
 - 176-Layer Micron TLC flash for example is only for embedded, higher P/E (5k) and available from 2024 until 2030



<100€



Product Lines

Feature/Description		Premium Uncompromising endurance/performance	Superior Mid-range endurance, enhanced ATP feature set	Value Mid-range endurance, mainstream feature set	Momentum Balanced Performance, mainstream feature set
NAND Type / Configuration		SLC, pSLC mode	TLC	TLC	TLC/QLC
Under Sudden Power Fail	Data Integrity	●	●	●	●
	In-Flight Data Coverage	●	●		
	Power Loss Protection Level	HW	HW / FW	FW	FW
Extended Commercial Temp (-20°C to 75°C) ¹					●
Industrial Temp (-40°C to 85°C) ¹		●	●	▲	▲
Customized HW Feature		▲	▲		
Customized FW Feature		▲	▲		
Customized Validation/ Testing Flow		▲	▲		
Fixed BoM		●	●	●	●
Longevity		> 5y	> 5y	> 5y	3y 2y **
L/T without FCST		14 w or longer	14 w or longer	12w	3w
LTB/LTS		6+6	6+6	6+6	6+6 3+3 **



Produktserien – Beständige Nomenklatur

N 65 1 S i a

Interface
Uppercase

N: PCIe (NVMe)
A: SATA
B: USB
I: PATA/IDE (CF)
S: SD/microSD
E: e.MMC/eMCP
U: UFS

Endurance
Numeral

80: SLC
75: High Endurance pSLC
70: pSLC mode
65: High Endurance TLC
60: Native TLC/MLC
50: Native QLC
40: Read-Intensive NAND

Technology Iterations
Numeral

Reserved to define Core technology/interface generation change

Product Line
Uppercase

P: Premium
S: Superior
V: Value
M: Momentum

Temperature
Lowercase

c: Commercial
i: Industrial
a: Automotive
w: Extended

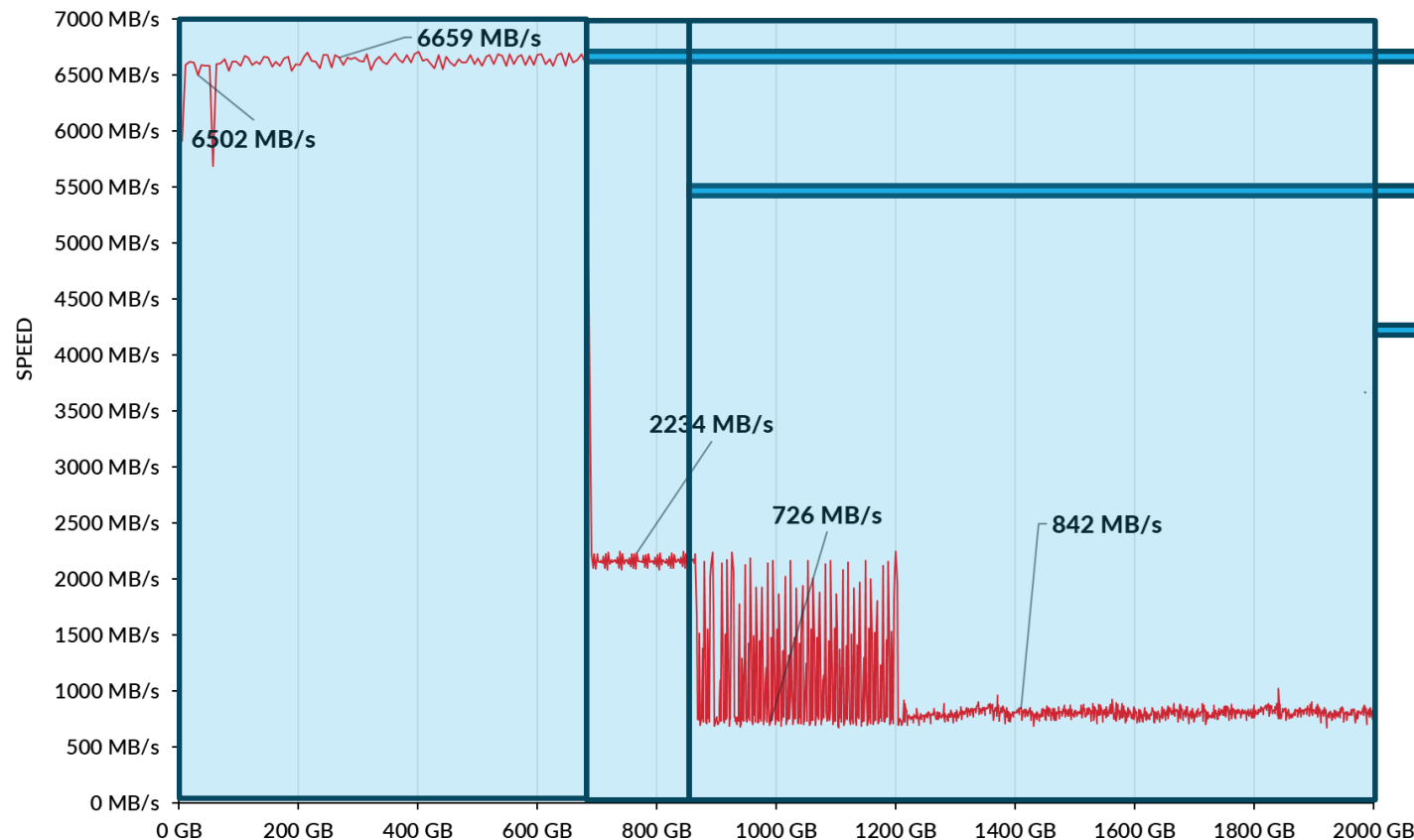
Series
Lowercase

a: Automotive
s: Securstor
e: Industrial Enterprise



Performance Cached

- **SSDs koenen 2 Cache-Stufen haben, DRAM und SLC Cache**
- **Leistungsabfall über die Belegung der Kapazität sieht so aus:**

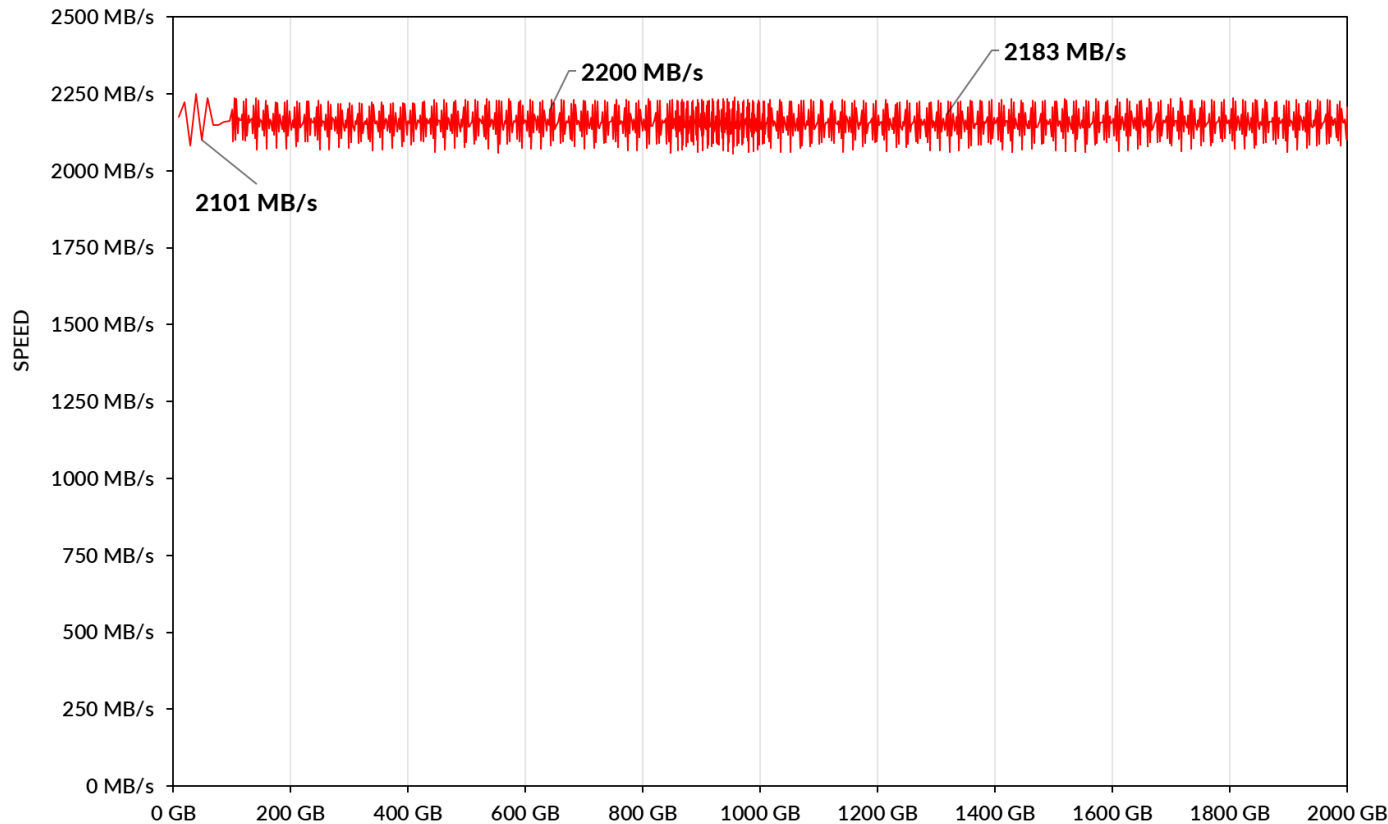


- **DRAM / SLC pCache aktiv. Die "Bis zu" Angaben...**
- **pSLC Cache aufgebraucht, schreibt nun TLC mode**
- **Re-organisiert den pSLC Cache parallel zum Schreiben von Daten**



Performance with no pSLC Cache

- **Das selbe Laufwerk, nur wurde kein pSLC Cache konfiguriert**
- **Das Ergebnis ist eine konstante Leistung über die gesamte Kapazität, Präparieren der SSD vermeidet sogenannte Garbage Collection und Einbrüche**





Legacy Storage Interfaces

- **SATA – literally no development since years – SATA3 is the latest**
 - 600MB/s is the limit, practically it's net rather 560-580MB/s
 - Used in 2.5", CFAST cards, M.2, mSATA
 - Vendors pull back from SATA market, in consumer SATA is dead already
 - Capacities are (more) limited in SATA, due to the controllers
- **USB – revised every few years – USB3.2 is the latest, USB4 coming**
 - 20Gbit / 2.5GB/s is the theoretical limit
 - Connector Type A and C
 - Used in USB sticks, eUSB drives, some M.2 have USB as 2nd interface (Key A & E)
- **PATA – aged interface, discontinued**
 - 133MB/s with DMA
 - Used in Compact Flash Cards still
- **SD – no further development**
 - UHS I supports up to 104MB/s
 - UHS II & 3 have additional contacts and go up to 312 / 624MB/s, in theory
 - SD express, based on PCIe, is the successor to this interface, but no adoption in the market is seen apart from camera vendors or embedded systems. It could drive 985MB/s but is largely outperformed by CFexpress – which became adopted in the market, e.g. by Sony and Nikon





Newer Storage Interfaces

■ eMMC

- Think of it like a MMC card (predecessor of SD/μSD) to solder down
- HS400 means up to 400MB/s, reality is more in the 150-300MB/s range
- All products must support native and pSLC mode for flash, configurable by end customers.
- 153-ball / 0.5mm ball pitch is the most common, next to 100 ball, 1mm pitch.



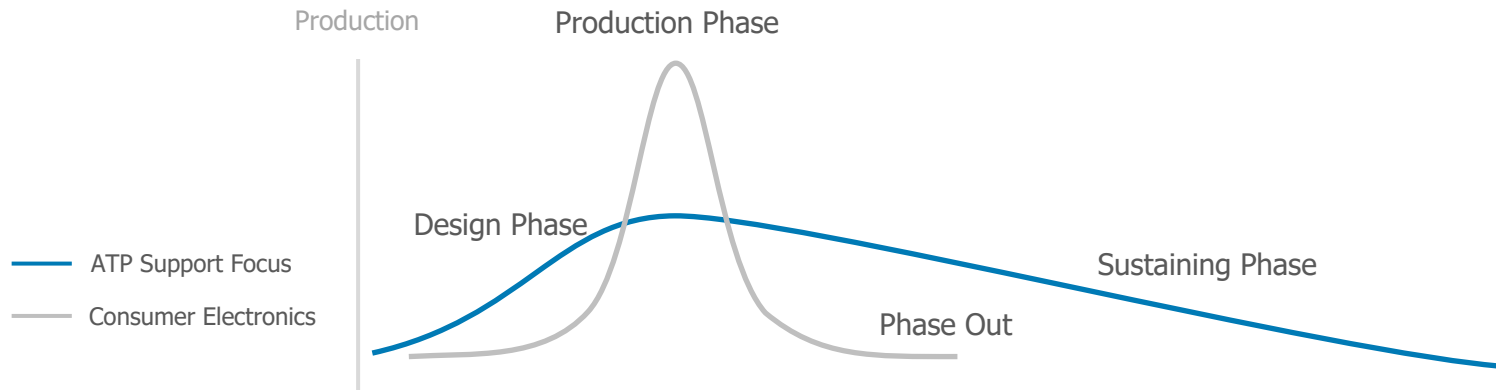
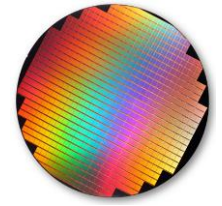
■ NVMe

- PCI Express is the base technology, a direct connection from peripherals and CPU
- NVMe is the protocol to address drives. (**N**on-**V**olatile **M**emory **E**xpress)
- Available as M.2, U.2, U.3, E1.S, CFexpress, BGA SSDs and in different generations (Gen1-5).
- Gen3 and 4 are current technologies, having 1 and 2 GB/s bandwidth per lane
- Drives have up to 4 lanes, resulting in 4 / 8 GB/s, Gen 5 has 16GB/s. Each Generation doubles bandwidth
- Performance of drives is limited by flash speed, no longer by the interface.
- Industrial controllers have up to 8 channels to address ICs, with up to 64 Chip selects to operate in interleave. The limitation of mainly write is <4GB/s sustained(!), so Gen3, 4 and 5 perform equally.
- NVMe drives are power-hungry, which often leads to thermal issues in embedded. It may make sense to operate in Gen3 to save power, or even just configure 1 or two lanes to limit the bandwidth.



Lebenszyklus

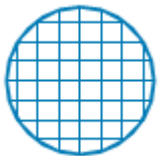
Wenn man fünf oder mehr Jahre das gleiche Produkt bauen möchte:



Complete Process Ownership



Partner
production
roadmap



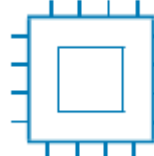
Obtain
screened
Lots of
wafers



Dice and
manage
wafer map



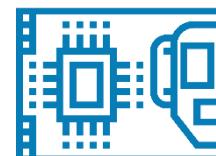
Stack
needed
Densities



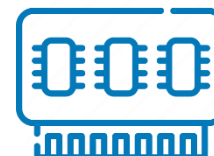
Pack
ATP IC's



Screening
on IC level



Use own PCB
designs, 3D
Solder Inspect



Manufacture
in 1000 ppm
N2 Reflow



Apply
custom
Firmware



Automated
testing of
all areas



Customize
Solutions



Zusammengefasst, was bietet ATP?

- **Produkte mit langem Lebenszyklus**
- **Für verschiedene Anwendungen passende Produktlinien**
- **Hohe Qualität in Fertigung und Komponentenauswahl**
- **Planbare und kommunizierte Migration zwischen Generationen**
- **Technische Finessen, um bekannte Probleme im industriellen Einsatz zu bewältigen.**
- **Engineering / Technischen Support in Europa**
- **Aussergewöhnliche Schreibleistung, bzw. Haltbarkeit in den Superior und Premium Produktlinien**
- **Technisch versiertes Personal, das gerne berät und die Optionen erläutert.**



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