

Industrial Flash Storage Design for Industrial AI Systems

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OUTLINE

- Introductions: AI, Smart Factories, Industrial AI, Industrial AIoT, ...
- Versatile Flash Storage and the Intelligence.
- Security in Storage for AI, Industrial, and IoT.
- Example: Industrial AI in a Smart Factory.
- Conclusions

Where / What is the AI?

Applications:

- Image Processing and Pattern Recognitions
- Medical Data Processing and Syndromes Identification.
- Robotics and Factory Automation:
- Autonomous Vehicles:
- ...

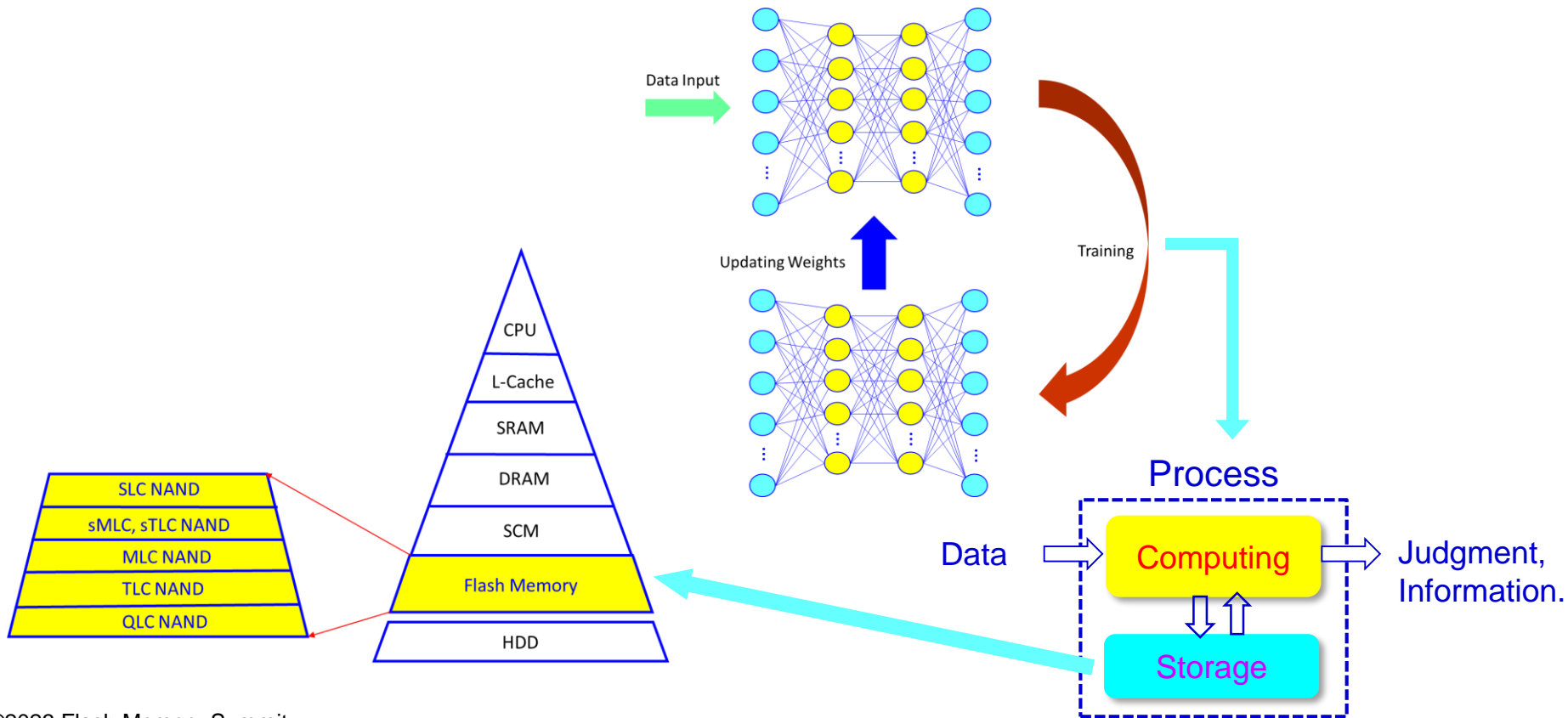
Locations:

- End-Points: simple and fast response.
- Edge: Local judgement.
- Cloud: Central Intelligent systems.
- ...

Performance:

- Accuracy: 80%, 90%, 99%, ...
- Speed (time): Latency, Throughput, ...
- Transparency: The rule base principles.
- Scalability: Cost, Complexity, Efficiency, ...
- ...

AI Model – the Storage for AI



■ Technologies for Smart manufacturing:

- **Data Technology (DT)**: the more data that is analyzed, the smarter the decisions.
- **Analytic Technology(AT)**: by application of statistics and mathematical tools to these data streams to assess and improve practices.
- **Operations Technology(OT)**: in conjunction with the other technologies, aims to achieve enterprise control and optimization via systems such as product lifecycle management, enterprise resource planning, manufacturing execution systems, customer relationship management, and supply chain management.
- **Platform Technology(PT)**: providing tools and flexibility needed to develop application-centric functions unique to each industry.

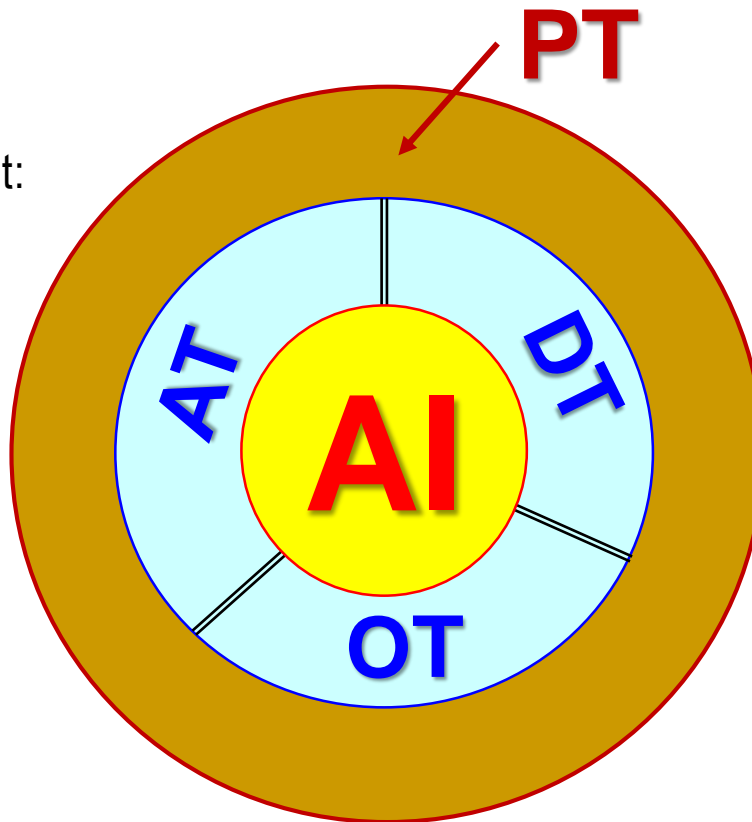
■ Industrial AI: AI as the core engine for DT, AT, OT and PT:

- AI-based approach: producing new value-creation; not only in solving visible problems but also avoid invisible ones; achieving Work reduction, Waste reduction, and Worry-free manufacturing.

Industrial AI: AI-based driving

Objectives:

- Operation efficiency:
- Productivity improvement:
- Quality control enhance:
- Forecast and inventory control enhance:
- Dangers and risks prevention:
- Predictive maintenance:
- Smart manufacturing:



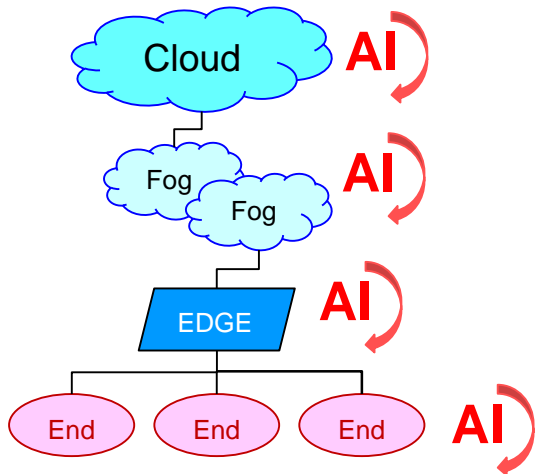
Characteristics:

- Focusing on problem-solving.
- >80% regular, which can be well pre-trained.
- Insight discovery with machine learning and data mining techniques.
- Industrial Big data analysis.
- Neural networks, machine learning, deep learning, and Fuzzy rules.

Industrial AI: Multi-structure

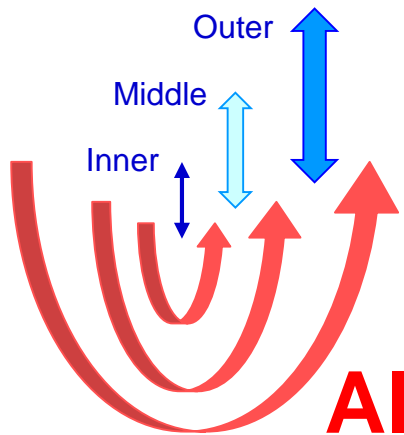
Multi-layer:

- AI on End-point:
- AI on Edge:
- AI on Fog:
- AI on Cloud:



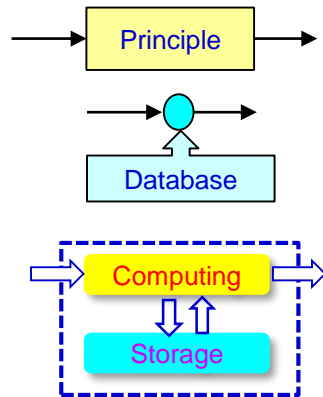
Multi-loop:

- Inner Loop: fastest response.
- Middle Loop: middle way
- Outer Loop: long / deep inferencing.



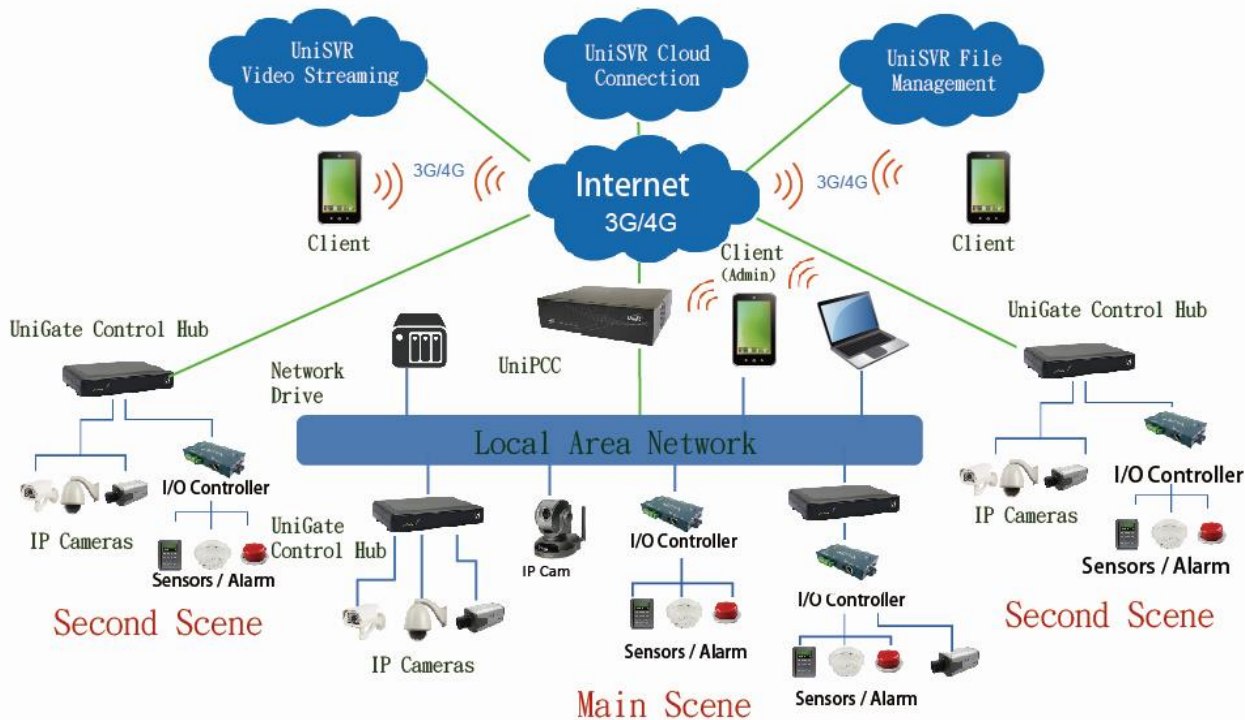
Multi-path:

- Experience Principle:
- Expert database lookup:
- Simple Training:
- Machine Learning:
- Deep Learning:



Embedded Flash Storage:

- For the “Things”: Sensors, Actuators, IP Cams, I/O Controllers. (Low density)
- For the Gateway: Controller Hub, Network Gateway. (Mid Density)
- For Edge Server: Edge AI, Edge Computing. (Mid to Large Density)
- For the Server: the Cloud, Data Center. (Large/Super Density)
- Data Logger for All: (Low Density)



Source: UNISVR

Versatile Flash Storage

Interface Types:

- SD:
- USB:
- PATA:
- **SATA:**
- eMMC:
- UFS:
- PCIe/NVMe:
- SAS:

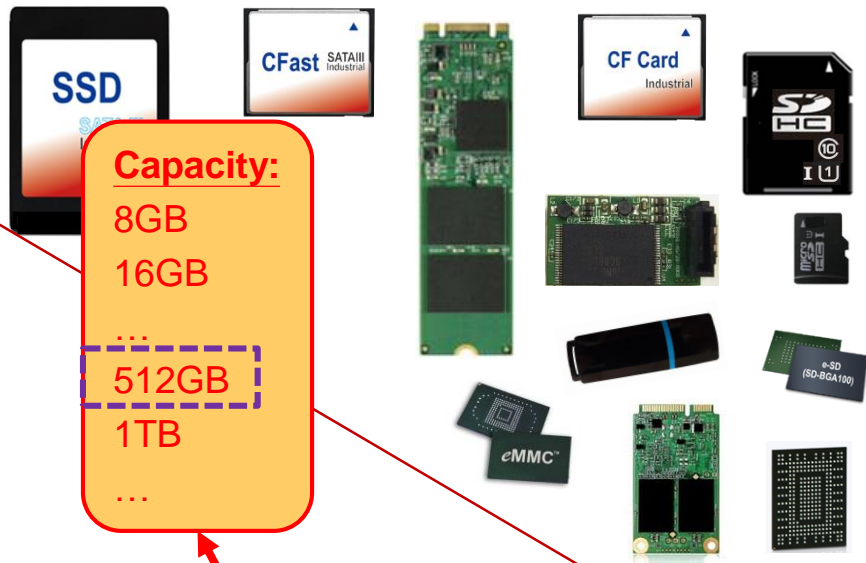
SATA Form-factor:

- 2.5" SSD:
- Half-slim:
- mSATA:
- M.2:
- BGA eSSD
- DOM:
- CFast:

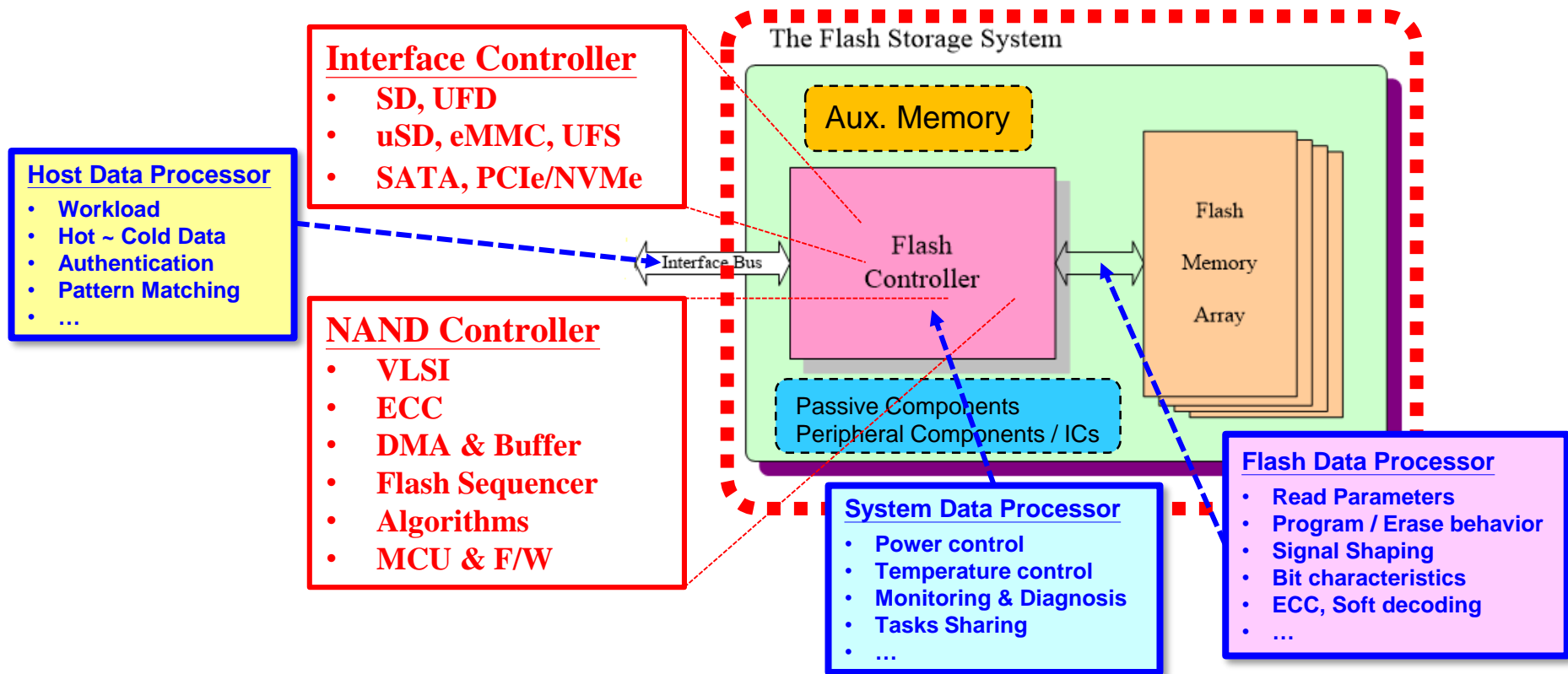
Capacity:

8GB
16GB
...
512GB
1TB
...

NAND Flash	SLC	sMLC	MLC	sTLC	TLC	QLC
WT (-40~85°C)						
ET (-25~85°C)						
CT (0~70°C)						



Concept of Intelligent Storage



Objective: to do the data processing near to the Storage.

- AI on Host-side: complying and fitting with Workload, “Hot ~ Cold” data analysis, Pattern recognition and pattern matching, Content finding, signature and authentication, ...
- AI on Flash-side: Read/Program/Erase behavior tracking and optimizing, ECC/RAID and flash memory maintenance, signal/data shaping, ...
- AI on System: Keeping the system stability in environmental variation. E.g., temperature control, power control, monitoring and diagnosis, ...

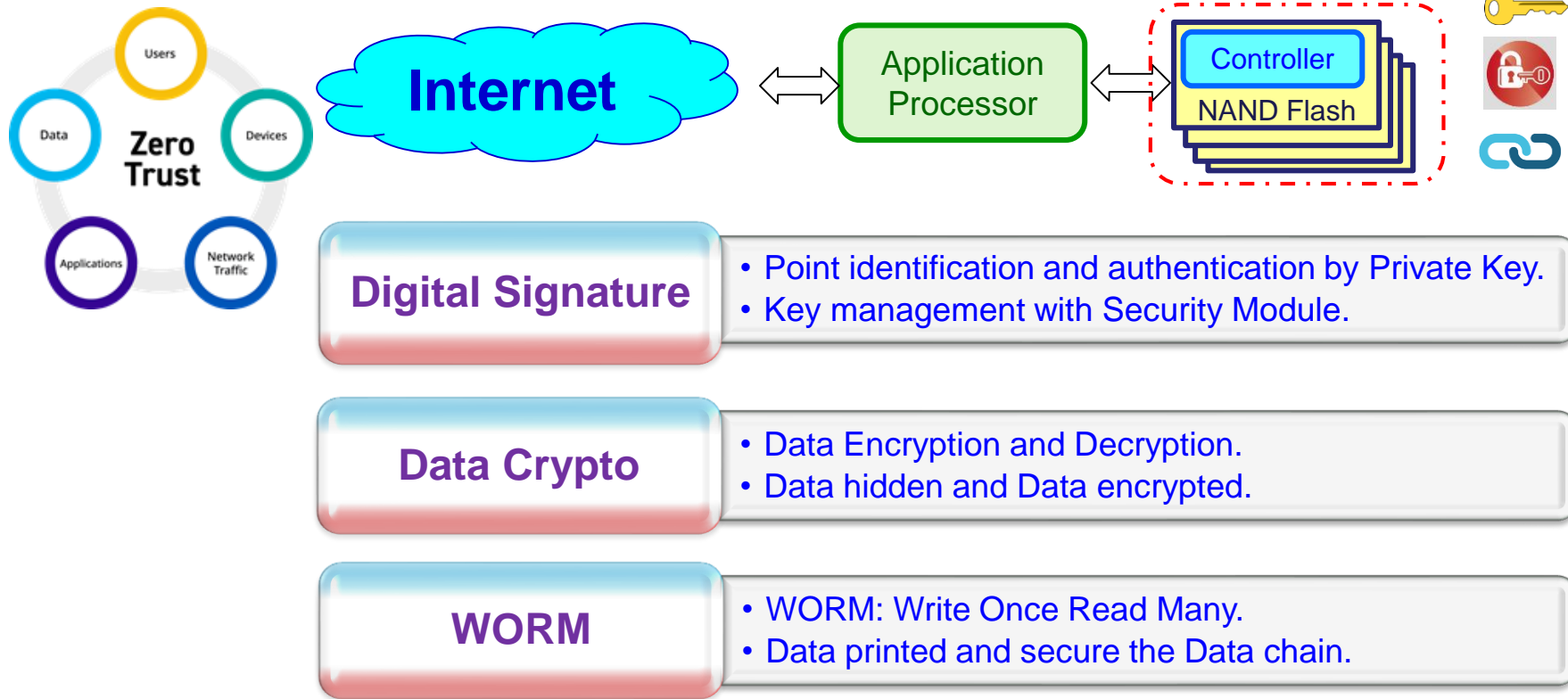
Methodology:

- Multi Core architecture: Data processors + Storage Controllers.
- Algorithms: Artificial Intelligence, Machine Learning, Fuzzy rules, Expertise lookup decision, ...
- Implementation: Convolutional Neural Network; Decision making by expertise database; Neuro-fuzzy control systems; ...

- **Intelligent Data Storage** is to minimize data movement and create intelligent computing close to data sources.
- Multi Core architecture: Data processors + Storage Controllers.
- AI algorithm for Storage and application specific functions. Parallel processing by tasks sharing to the data processors in Data Storage device.
- Provide the vendor application commands over NVMe and side-band (OOB) interface.

Specifications:

- PCIe/NVMe Gen-4 x1/x2/x4 configurable SSD.
- Intelligent Flash memory maintenance;
- Informative S.M.A.R.T support.
- Vendor commands for application specific functions.
- Remote control & management.
- Flash memory: 2D MLC, 3D TLC.
- Advanced ECC with RAID function.
- Wide temperature:
 - Industrial Grade: -40°C ~ 85°C
 - Standard Grade: 0°C ~ 70°C
- Power management.



■ Security Feature Storage

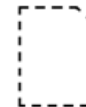
- Security Digital Key: Can be used as digital signature to provide the users' identity certification and the accessing authority authentication.
- Security Write Protect: Prevent the data be erased, modified or overwritten by unauthorized user through Security Key stored in the card itself.
- Security Hidden: Allow authorized user to access the data through Security Key authentication.
- Security Hidden Read-Only: Allow authorized user to read the data through Security Key authentication.



Write Protect



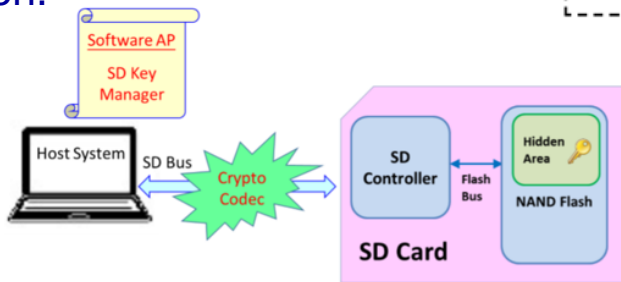
Data Hidden



Data Hidden

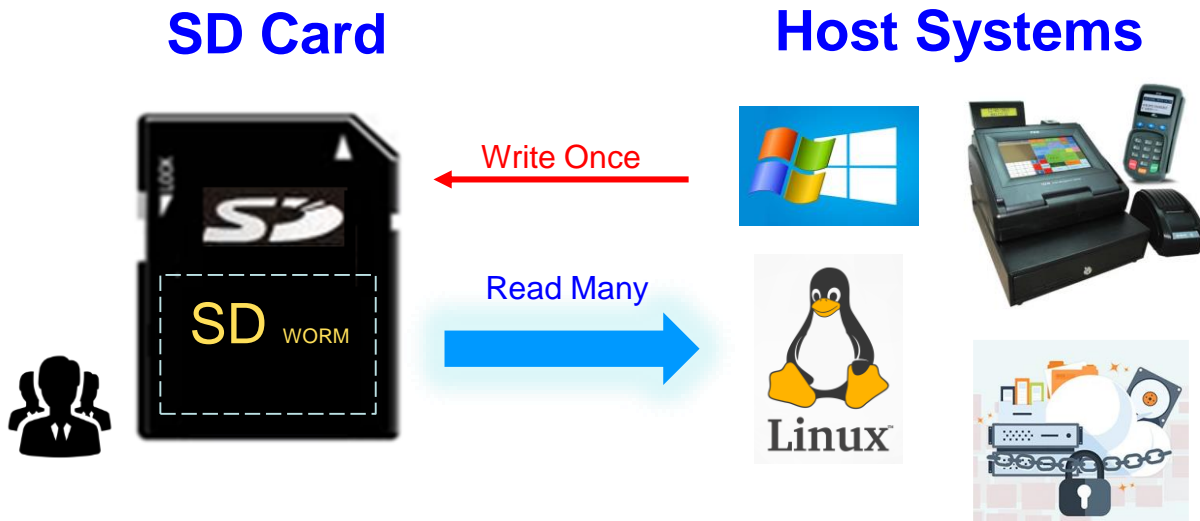


Write Protect

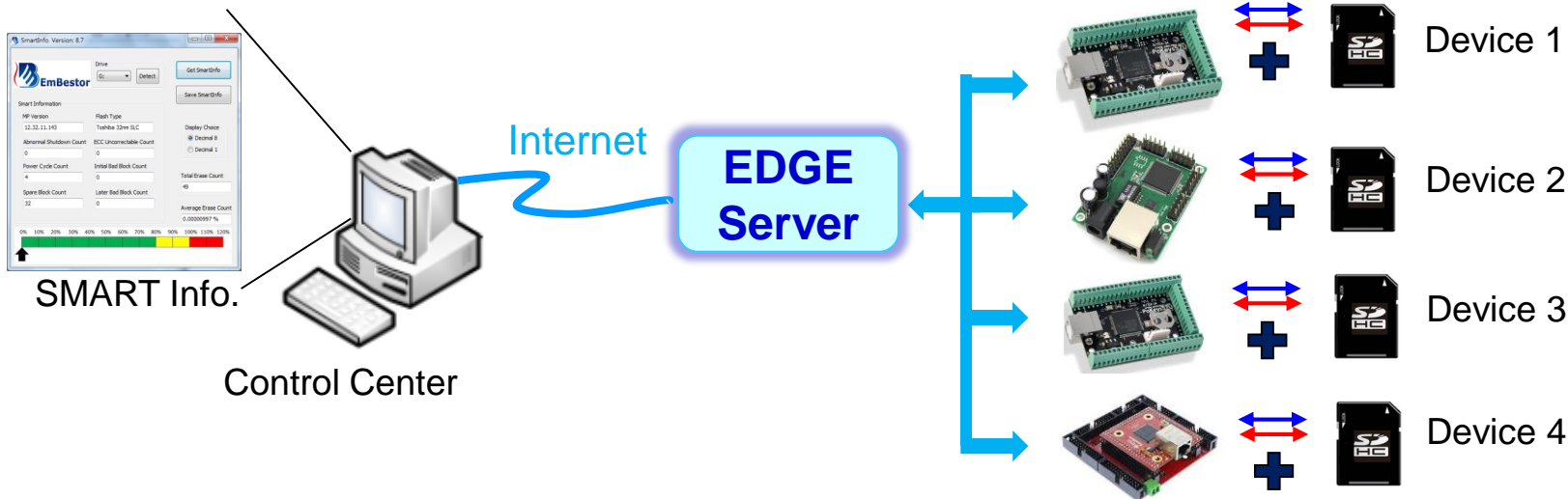


WORM (Write-Once, Read-Many)

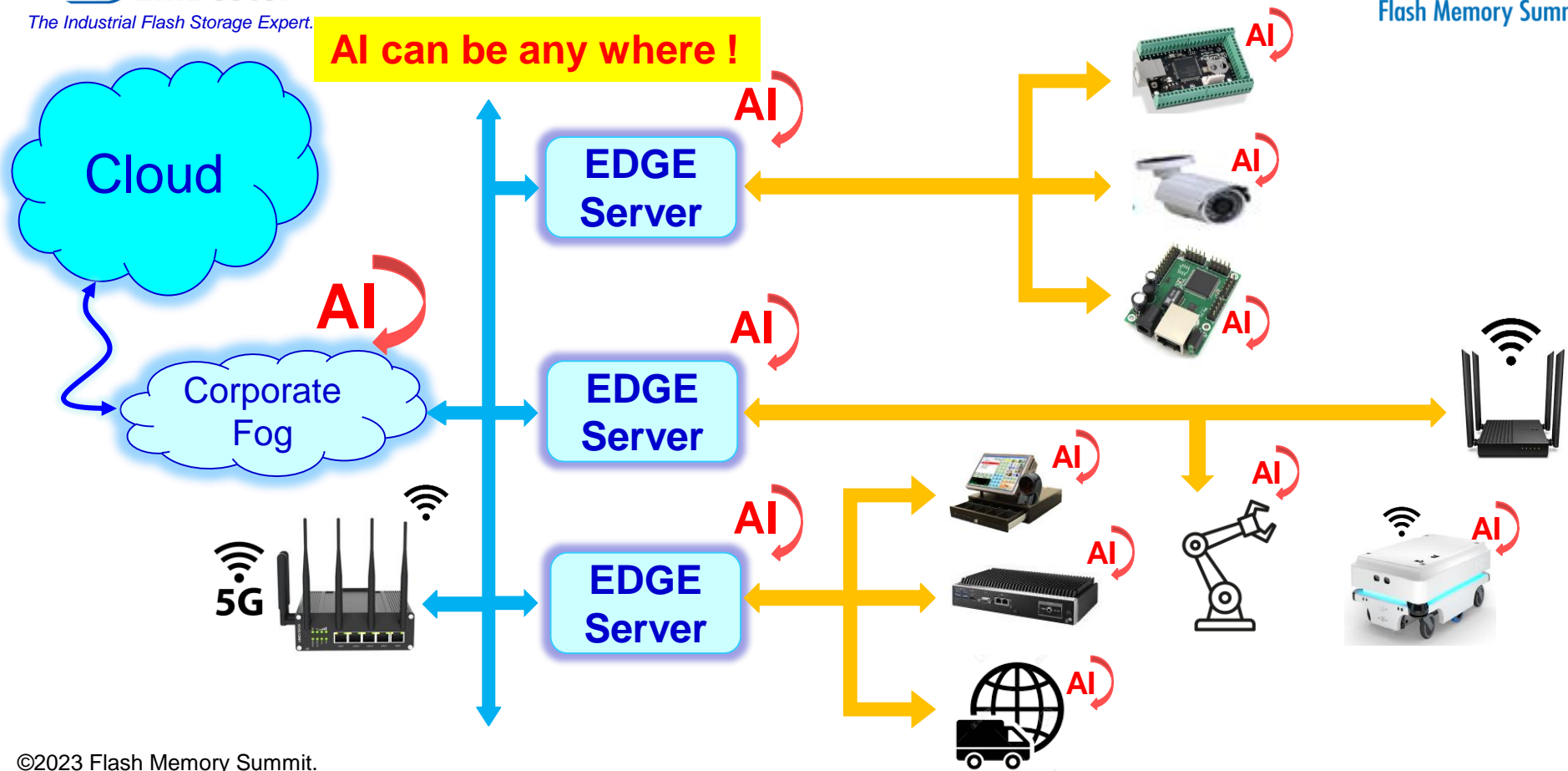
- WORM Storage devices support the Write-Once, Read-Many applications.
- Applications: Fiscal/Tax data, Legal evidences / statements, e-Certificate, Medical records, Important data backup, etc.
- Providing the native data block-chained as the data recorded.



- Host can get more of device's SMART Information easily with multiple ways.
- Remote monitoring and maintenance with System Re-start, Self-repair, F/W upgrade.
- Support Customized Windows AP, the normal reader could get the SMART Info.
- Support SDK for several Linux OS versions.



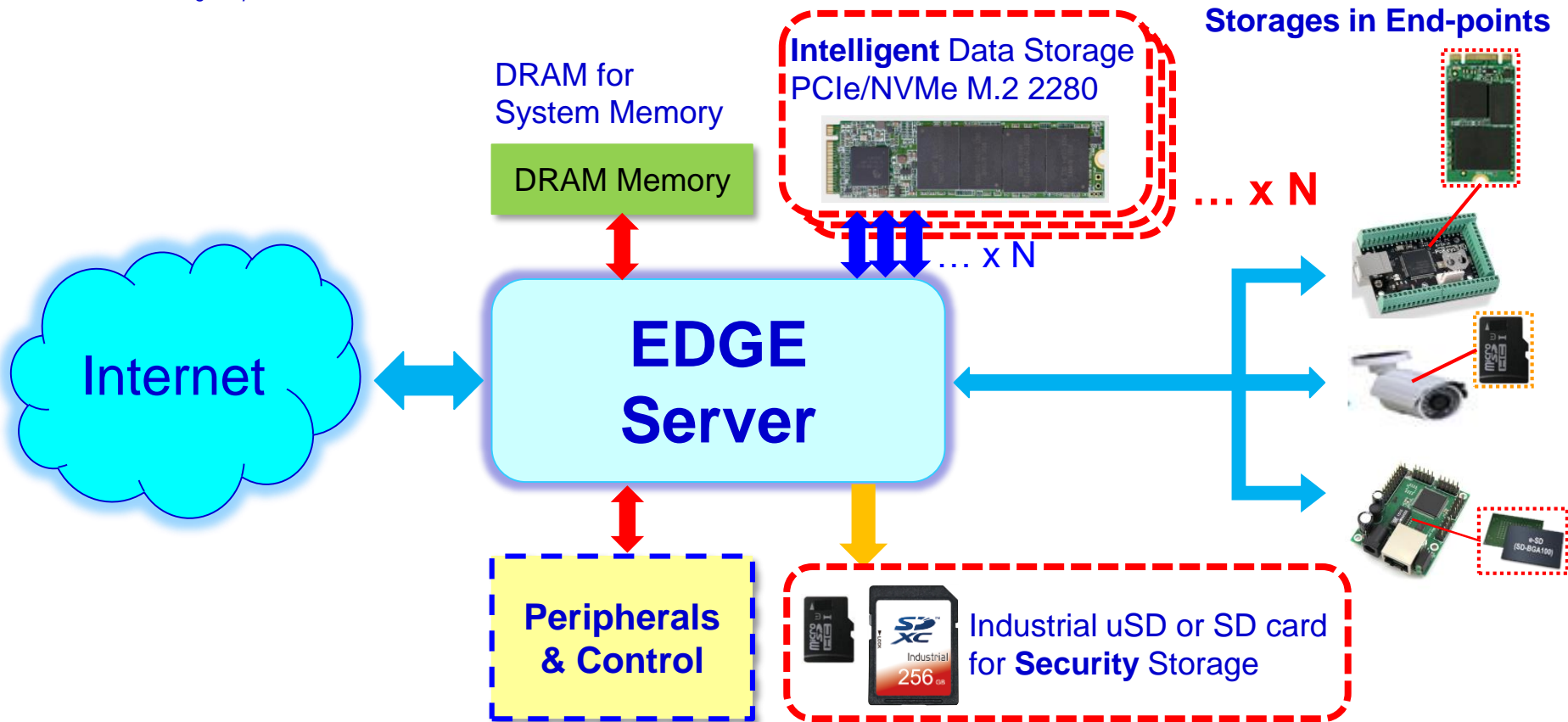
EX: Industrial AI in a Smart Factory



Flash Storage for Industrial AIoT



Flash Memory Summit



Conclusions

- Industrial AI systems has been introduced: AI, AIoT, Industrial applications, Smart factories, ...
- Versatile Flash Storage and the Intelligences has been presented.
- Security feature provides the safety and stability of AI, Industrial, and IoT.
- An example: Industrial AI systems and the Flash Storage Design in a Smart Factory has been illustrated.

Thank You !!

Enjoy Best Service !!

