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ASX: NVU

EMASS To Embed ReRAM Technology For Improved Scalable, Energy-Efficient Memory

Highlights:

- Embedded AI System Pty Ltd (EMASS) has commenced the transition from Spin Transfer Torque Magnetic RAM (STT-MRAM) to Resistive Random Access Memory (ReRAM), incorporating next-generation memory technology to further its mission to deliver high-performance, energy-efficient AI applications.
- ReRAM delivers higher scalability, faster read and write speeds, and increased data density, with a lower energy consumption specifically for reads, ideal for Nanoveu's target markets for EMASS technology including IoT, consumer electronics, AI, and automotive applications.
- EMASS core team has developed proprietary techniques to overcome ReRAM inherent limitations, such as endurance, to enable longer operation lifetime with negligible overheads at the system level. These techniques include wear-leveling, error-correcting codes, and fine-grained integration of compute units with ReRAM.
- The shift to ReRAM aligns EMASS with an industry-wide trend, as major players like Crossbar Inc., Weebit Nano**,** and Nantero are advancing ReRAM for use in IoT, automotive, and AI application positioning EMASS at the forefront of next-generation memory technology.

Nanoveu Limited ("Nanoveu" or the "Company") (ASX: NVU) is pleased to announce EMASS, a company under a binding heads of agreement and soon to become its wholly owned subsidiary (subject to shareholder approval and key terms listed in Annexure A-ASX Announcement 15th October 2024)[1], is transitioning from Spin Transfer Torque Magnetic RAM (STT-MRAM) to Resistive Random Access Memory (ReRAM) technology to further advance its position as an industry leader in highly scalable, energy-efficient, System on Chip (SoC) technology.

Advantages of ReRAM

ReRAM is gaining traction as a superior alternative to STT-MRAM for small form factor devices expected to run memory-intensive applications, such as 2D to 3D image conversion. With faster read and write times, lower energy requirements, greater scalability, and even the ability to store multiple bits in a single ReRAM cell, ReRAM meets the growing demand for memory solutions capable of supporting next-generation systems in IoT, automotive, and consumer electronics. Major players like Crossbar, Weebit Nano (AUD ~$619m market cap), and Nantero are driving ReRAM adoption, signaling its readiness for large-scale deployment.

EMASS Proprietary Innovations Address ReRAM Endurance Challenges

While ReRAM offers significant advantages in scalability, speed, and energy efficiency, its wider commercial adoption has faced industry-wide technology-specific limitations such as limited number of writes per single ReRAM bit before permanent failure (known as limited endurance: ReRAM has 10^6 write cycles before failure akin to FLASH memory, whereas DRAM has 10^{15} write cycles). However, EMASS founder, Dr. Mohamed M. Sabry

[1] ASX Announcement 15 October 2024

Aly - a recognized leader in advanced memory systems - has developed proprietary resilience mechanisms that significantly enhance ReRAM's durability and enable EMASS to take advantage of ReRAM's unique comparative advantages without compromise especially for computationally demanding applications like deep learning and AI image conversion.

These innovations include techniques such as fine-grained compute integration, endurance optimisation strategies, wear-leveling, and error-correcting codes—designed to mitigate wear and extend ReRAM's operational lifespan. While some of this foundational work has been published in leading journals such as Proceedings of IEEE (2019), ISSCC (2019), and IEEE Transactions on Electron Devices (TED, 2019), the core intellectual property is exclusively owned by EMASS (Nanoveu), ensuring a competitive edge in commercial applications.

These results have been validated through comprehensive peer comparison evaluations [2], confirming EMASS's significant power efficiency advantages over industry peers. The transition to ReRAM is anticipated to deliver further performance benefits, solidifying EMASS's position as a leader in energy-efficient embedded AI solutions.

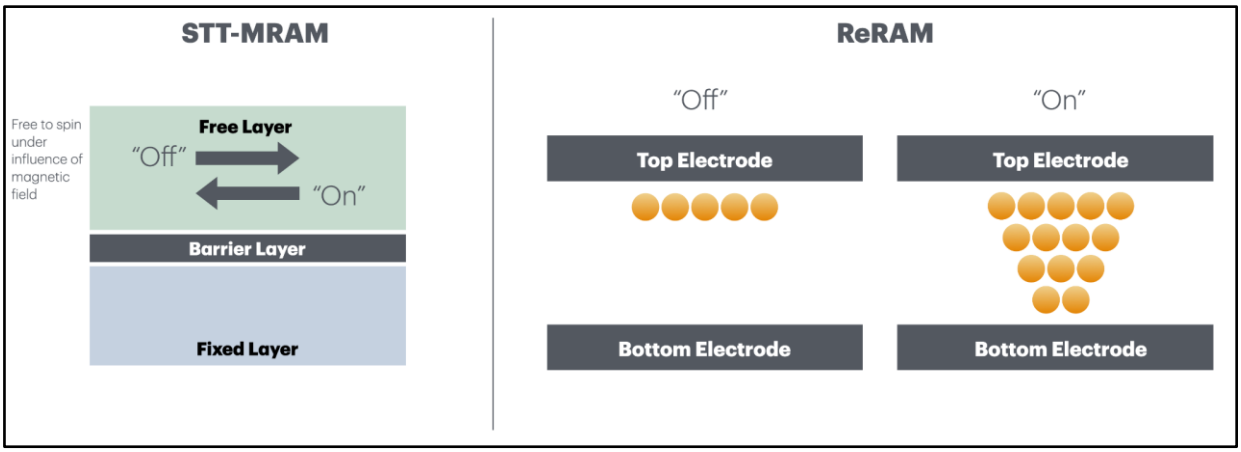

Figure I. Schematic representation of switching states, ReRAM vs STT-MRAM

STT-MRAM: Uses magnetic states to store data, requiring precise control of magnetic fields and currents. This is still detected as a change in resistance value, where the difference between the value for a logic '0' and a logic '1' can be 2x at best
ReRAM: Uses resistance changes in a material to represent data. the resistance is changed by forming/destroying a conductive path in a dielectric between two electrodes. The difference in resistance values between the states representing '0' and '1' is orders of magnitude which can make ReRAM much more energy efficient. Additionally, ReRAM uses materials that are more compatible with the standard IC manufacturing, which is ReRAM is often more scalable.

Commercialisation and Market Positioning

Nanoveu is actively pursuing commercialisation opportunities for its ReRAM-supported EMASS chips and IP portfolio such as licensing agreements and long-term partnership, focusing on sectors with high growth potential, including:

- **IoT:** Where low-power, high-speed data processing for connected devices is essential.
- **Automotive:** Where scalable memory solutions can help enhance autonomous vehicle systems
- **Industrial Systems:** Where energy-efficient AI-driven automation is required.
- **Consumer Electronics:** Delivering faster, smarter, and more energy efficient ("greener") devices.

[2] See ASX releases 22 October 2024 and 12 November 2024

Prof. Mohamed M. Sabry Aly, Founder of EMASS commented: *"Our transition to ReRAM from MRAM aligns with our mission to develop the industry's most scalable and energy efficient chips. We are positioning ourselves to meet growing global demand for low energy but powerful chips driven by the increasing demand for AI-supported applications. Our team's extensive expertise in ReRAM allows us to address the technology's unique challenges, such as endurance and error rates, and implement proprietary solutions that ensure successful deployment in our embedded AI systems. It is also worth mentioning that we are not tied to either memory technology. If tomorrow another XRAM is developed, we possess the capability to integrate it into our system and even address any inherent limitation of the technology at the system level— this is what makes us in EMASS unique."*

Explainer: ReRAM vs. STT-MRAM

ReRAM (Resistive Random Access Memory) and STT-MRAM (Spin Transfer Torque Magnetic RAM) are two advanced types of memory technology designed to store data in modern devices, but they work in fundamentally different ways and are suited for different purposes.

STT-MRAM uses magnetic fields to store data. It's incredibly fast and retains information even when the power is turned off (non-volatile). However, it requires more energy to operate and has limitations in how densely data can be stored, which makes scaling for advanced applications challenging. Also the magnetic states that represent a logc '0' and logic '1' is very low in STTRAM rendering it slower in read as the sensing circuitry will require a longer time to distinguish between the levels of '0' and '1'.

ReRAM, on the other hand, stores data by changing the resistance of a material. This is done by forming/destroying a number of conductive routes in a dielectric material.
Unlike STT-MRAM, the resistance states representing '0' and '1' havea huge gap between them (can reach 100X) which allows the read circuitry to run faster, and even enabled ReRAM to store multiple bits in a single cell. It's also non-volatile but offers key advantages:

- Higher Density: - meaning more data can be stored in a smaller space.
- Lower Energy Use - writing data requires significantly less power, making it ideal for applications where energy-efficiency is crucial
- Faster Access Times - means ReRAM can read and store data more quickly than many other memory types.

While ReRAM does face durability and variation challenges with frequent use, innovations like those developed by EMASS have significantly improved its endurance. This makes ReRAM an excellent choice for integrating into the EMASS chips to support applications such as AI, IoT, and automotive systems, where scalability and efficiency are critical.

This announcement has been authorised by the Board of Directors of Nanoveu Limited.

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About Nanoveu Limited

Nanoveu is a company specialising in advanced films and coatings. https://www.nanoveu.com/.

Further details on the Company can be found at https://wcsecure.weblink.com.au/pdf/NVU/02656570.pdf.

EyeFly3D™

The EyeFly3D™ platform is a comprehensive solution for delivering glasses-free 3D experiences across a range of devices and industries. At its core, EyeFly3D™ combines advanced screen technology, sophisticated software for content processing, and now, with the integration of EMASS's ultra-low-power SoC, powerful hardware.

Nanoshield™ - is a self-disinfecting film that uses a patented polymer of embedded Cuprous nanoparticles to provide antiviral and antimicrobial protection for a range of applications, from mobile covers to industrial surfaces. Applications include:

> ***Nanoshield™ Marine***, which prevents the growth of aquatic organisms on submerged surfaces like ship hulls, and
>
> ***Nanoshield™ Solar***, designed to prevent surface debris on solar panels, thereby maintaining optimal power output.

EMASS (to be acquired by Nanoveu, subject to shareholder approval[3])

EMASS is a pioneering technology company specialising in the design and development of advanced systems-on-chip (SoC) solutions. These SoCs enable ultra-low-power, AI-driven processing for smart devices, IoT applications, and 3D content transformation. With its industry-leading technology, EMASS will enhance Nanoveu's portfolio, empowering a wide range of industries with efficient, scalable AI capabilities, further positioning Nanoveu as a key player in the rapidly growing 3D content, AI and edge computing markets.

Forward Looking Statements

This announcement contains 'forward-looking information' that is based on the Company's expectations, estimates and projections as of the date on which the statements were made. This forward-looking information includes, among other things, statements with respect to the Company's business strategy, plans, development, objectives, performance, outlook, growth, cash flow, projections, targets and expectations and related expenses. Generally, this forward-looking information can be identified by the use of forward-looking terminology such as 'outlook', 'anticipate', 'project', 'target', 'potential', 'likely', 'believe', 'estimate', 'expect', 'intend', 'may', 'would', 'could', 'should', 'scheduled', 'will', 'plan', 'forecast', 'evolve' and similar expressions. Persons reading this announcement are cautioned that such statements are only predictions, and that the Company's actual future results or performance may be materially different. Forward-looking information is subject to known and unknown risks, uncertainties and other factors that may cause the Company's actual results, level of activity, performance, or achievements to be materially different from those expressed or implied by such forward looking information.

[3] ASX Announcement 15 October 2024