Magnetic Memory based secure devices

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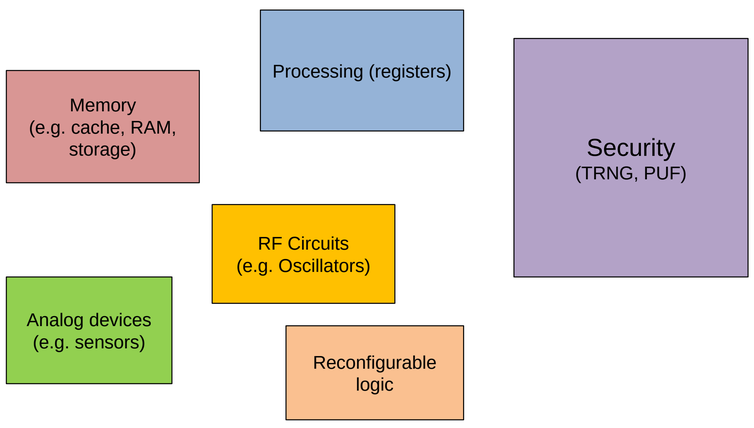
CONTEXT & MOTIVATION

Magnetic Tunnel Junction (MTJ) is suitable for a wide range of applications



Physical Unclonable Function (PUF)

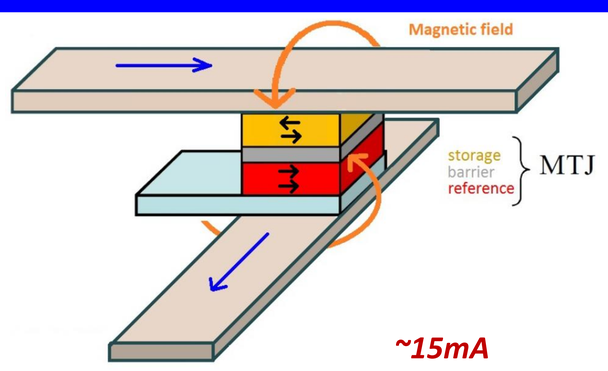
Magnetic Tunnel Junction (MTJ) is suitable for two mains hardware security applications

True Random Number Generator (TRNG)

- **Physical Unclonable Function (PUF)**
  - **Application**
    - Secure authentication
  - **Manufacturing variability**
    - Variability of electrical resistance of MTJ
- **True Random Number Generator (TRNG)**
  - **Application**
    - Random cryptographic keys
    - Statistical sampling
    - Advanced simulation techniques
  - **Source of randomness from STT-MRAM**
    - Stochastic nature of STT switching

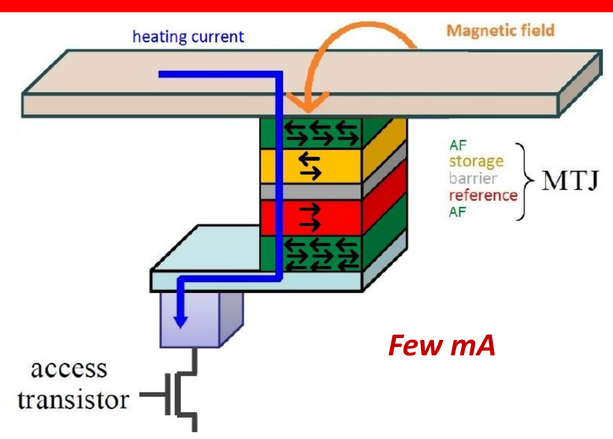
MAGNETIC RANDOM ACCESS MEMORY (MRAM) TECHNOLOGIES

Field Induced Magnetic Switching (FIMS)



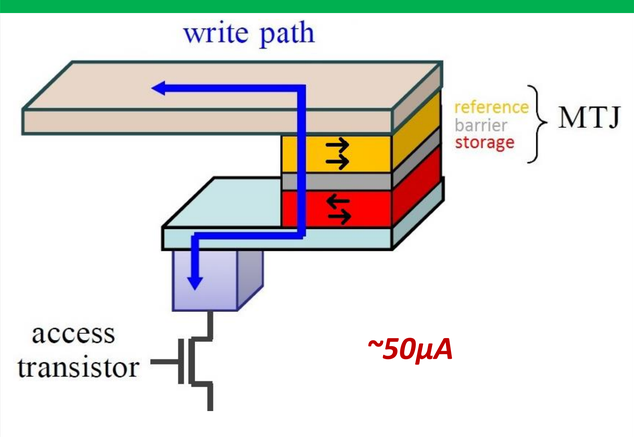
- First MRAM generation
- Two combined magnetic fields may flip the free layer magnetization

Thermally Assisted Switching (TAS)



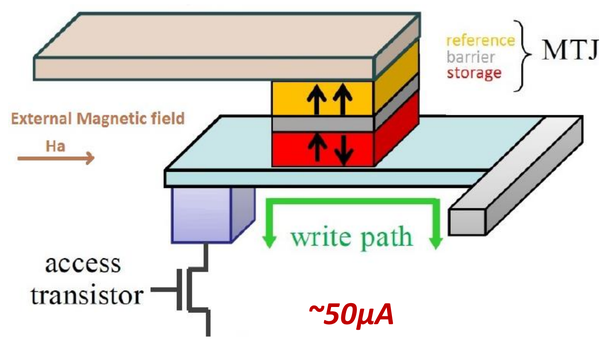
- FM layers' magnetization is blocked at room temp.
- Heating the junction unblocks the free layer

Spin Transfer Torque (STT)



- Spin-polarized current can flip the free layer
- No external magnetic field needed
- Shared read/write path

Spin Orbit Torque (SOT)



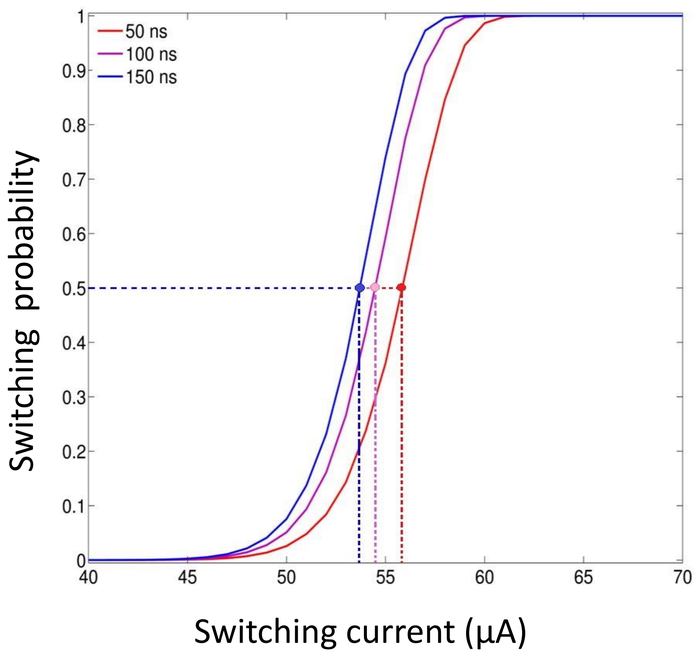
- SOT switching is currently not fully understood
- Separated read/write path

MRAM-BASED SECURE DEVICES

MRAM-based TRNG Principle

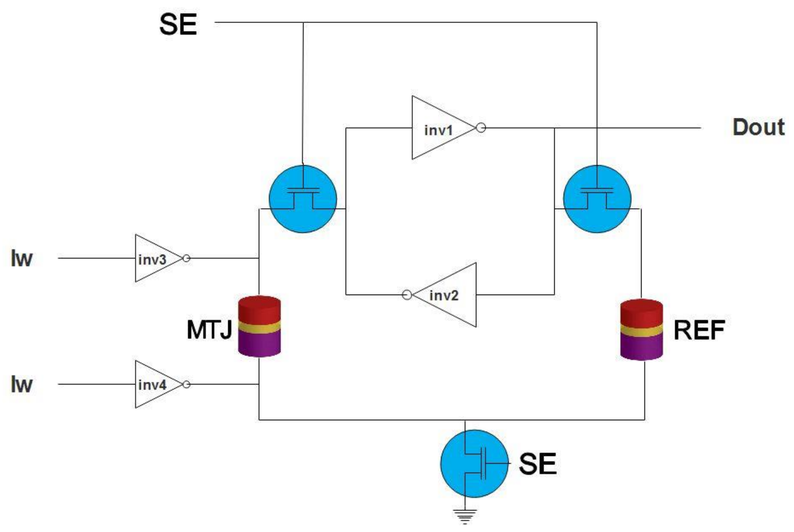
TRNG principle

- STT-MRAM switching is stochastic dependent and probabilistic
- The switching probability depend on :
  - Writing current value
  - Writing pulse time

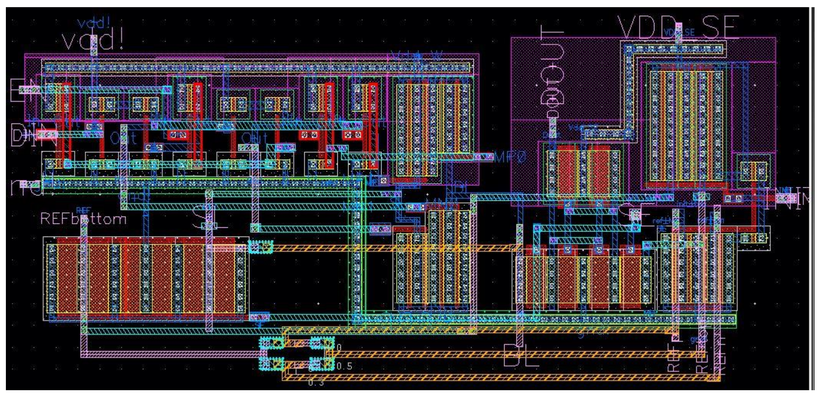


MRAM-based TRNG basic cells

TRNG VLSI structure

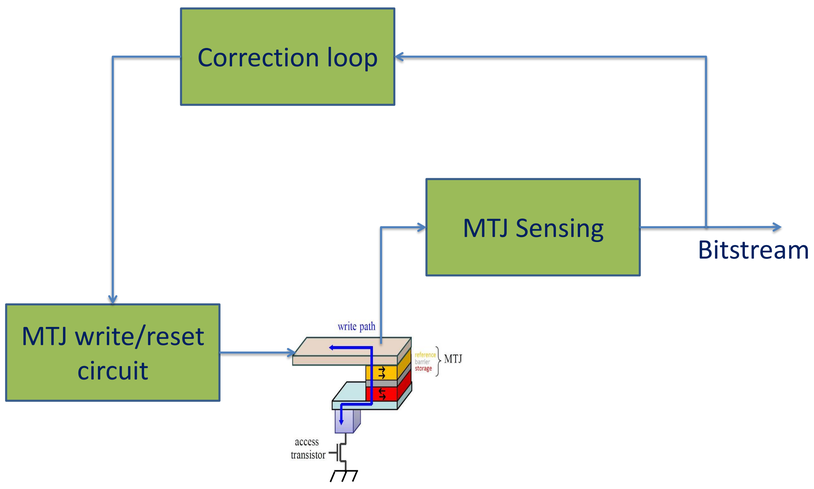


TRNG circuit



MRAM-based TRNG with feedback

TRNG Control feedback



- Correction loop will act on writing current or writing pulse time
- Generate accurate random bitstream in standalone

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