FDSOI FACTORS OF SUCCESS PAVE NEW ROADMAPS

2017 SOI Consortium Event, Marie-Noelle Semeria
OUTLINE

Factors of Success
- Power
- Flexibility
- RF
- Robustness
- Cost

New Fields of Application
- IoT
- 5G mmW
- Transportation

New Routes for the Future
- Quantum
- Nanosystems
- Light
INTRODUCTION - CONTEXT

2 main alternatives below 28nm

14nm:
- Intel
- TSMC
- Samsung
- GF

FinFET
Symmetrical double gate

28-14nm:
- ST Micro
- GF
- Samsung

FDSOI MOSFET
Asymmetrical double gate

10nm node: FinFET versus FDSOI MOSFET
FDSOI: A DEMONSTRATED LOW-POWER TECHNOLOGY

[Beigne et al. JSSC 2015]

The Best Performance / Power Consumption Tradeoff

FRISBEE

Supply Voltage (V)

Frequency (MHz)
ULV DESIGN: FDSOI BOOST

DSP + SRAM @ Iso-Performance (32 MHz)

Ultra-Low Power demonstrated

- Bulk 65nm
- FDSOI @ 0.6V
- FDSOI LETI @ 0.525V

Ptot (µW)
RF PERFORMANCE FDSOI VS FINFET

Cut-off Frequency ($f_T$) GHz

- Litterature
- FDSOI Data
- FinFET Data
- FDSOI projection
- FDSOI Trend
- FinFET Trend

 Outstanding
FT and FMAX @ 390 GHz
FDSOI: A FULL ROADMAP DOWN TO 10NM

- **28nm FDSOI**
  - cSiGe PFET
  - In situ doped RSD
  - 20nm BOX

- **22nm FDSOI**
  - cSiGe PFET
  - In situ doped RSD
  - 20nm BOX

- **14nm FD-SOI**
  - Continuous RX
  - In situ doped RSD\(^{Gen2}\)
  - 20nm BOX

- **10nm FD-SOI**
  - L- \(sSOI\) NFET
  - 3rd Gen cSiGe PFET
  - 2nd Gen RSD
  - 15nm BOX
  - Dual STI

Stronger Design-Technology Interaction
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IoT – 5GmmW – Transportation

New Routes for the Future
Quantum – Nanosystems – Light
FDSOI decreases power consumption up to 8x compared to CMOS65nm @ iso-performance

8x battery lifetime
8x performance @ same power consumption

Autonomous IoT Devices (w. energy harvesting solutions)

Medical Devices with Large Autonomy
Autonomous devices for Structural Health Monitoring
Connected Watch
L-IOT : AN IOT « CONCEPT-CAR »

Service Network for Configuration
Automatic sleep mode
30x30µm² /interface

Voltage Hopping
0.5V - 0.8V - 1V
<100ns transition
~nW leakage

Adaptive Wake-Up Radio
50µW active, 1µW stdby

Asynchronous Wake-Up Controller
<1µW/MHz
Automatic sleep mode

Real-time Clock
60nW 40KHz

3T FDSOI Pixels – FDSOI Photodiodes

Power-Management Unit (PMU)

Battery / Energy Harvester

Configuration Management Unit (CMU)

Wake-up Radio
Wake-up Sensors
Wake-up Imager
Wake-up Timers

Wake-up Ctrl
Energy control

CPU (Register)
Memory (SRAM & eNVM)
Co-processing (N, crypto, data fusion, Imager)

Radios
Sensors
Imager

Always-Responsive Sub-system

Asynchronous Wake-Up Controller
<1µW/MHz

Asynchronous Energy Controller
88nW@250 events/s

On-Demand Sub-system

Cortex M0+
5.4uW/MHz@0.5V 50MHz

NV Cortex M0+
CBRAM or MRAM

Ultra-Narrow Band
Tx/Rx - 20mA to 75mA in Emission
5G requires opening new spectrum in cm and mm wavelengths

Modules working > 24 GHz are envisaged
- They will require strong RF front-end and high-performance digital baseband

FDSOI provides the perfect RF / digital tradeoff @ low cost!

Source: Nokia
Transportation requires more and more computing power…

- A car becomes a connected computer with 4 wheels!
- Automatic control and autonomous driving for public transportation
- Boost of computing in avionic

But is facing challenges in terms of reliability

- Certification
- Low error rate / high reliability required

FDSOI provides first-class behavior to electro-magnetic disturbance AND the required computing power

Source: ST
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FDSoI OPENS TO QUANTUM COMPUTING

First 300mm Qubit Demonstrated!
Optical Back Bias Effect: Efficient Photodetectors!
Computation immersed in memory

- Increased functionality
- Memory
- Computing logic
- Fine-grained, ultra-dense 3D
Final Implementation

- 2 Layers at 28nm FDSOI
- RRAM Implemented in the Interconnect
- Analog Hierarchical Spiking Architecture
- Test and Programming Environment
FDSOI Pave New Roadmaps for Each Low Power- Low Cost Application