Experiences with Aging Simulation

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BOSCH

Experiences with Aging Simulation
Motivation

- Devices in state-of-the-art semiconductor processes can be operated in regions where degradation may happen
- Aging simulation needed to take the effect of device degradation during design into account
- Aging models needed for relevant degradation mechanisms

- At Bosch, process design kits (PDKs) from different vendors are used
- Aging simulation not supported in every PDK

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History

- Main Activities of Bosch regarding reliability simulation within funded projects:

- Project ELIAS (2007..2010): RelXpert URI improved for support of subcircuit device models (Cadence has been project partner) ➔ Implementation into Cadence 5.1.41

- Project RESIST (2014…2017): Improvement of reliability simulation flow to support (i.e. enhance) process design kits from different vendors

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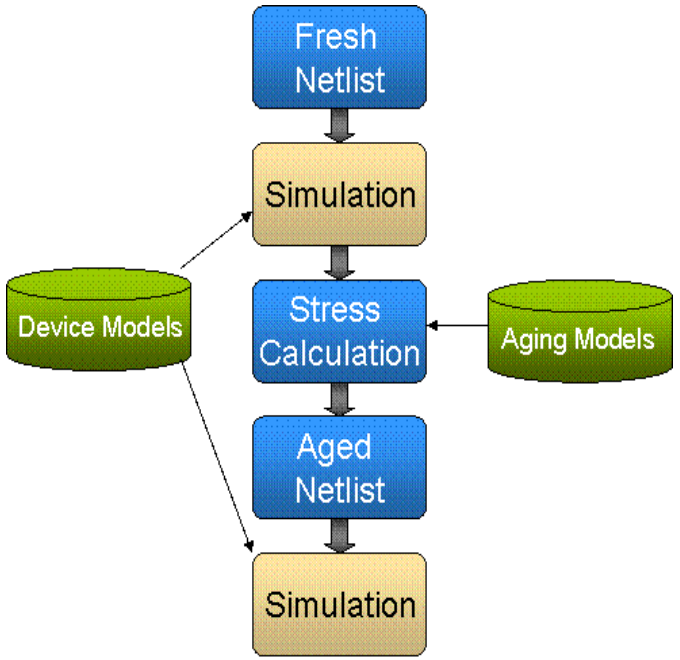
Aging Simulation Flow with RelXpert



- Flow is based on BERT methodology (Berkeley Reliability Tools, 1990)
- Stress is calculated for each device from a transient simulation by use of (built-in or user defined) models describing aging as function of operating point, temperature and time
- From extrapolation to a specified lifetime, degraded model parameters are calculated and an aged netlist is generated
- With this netlist, simulation of the “aged” circuit can be performed
- RelXpert is implemented in Cadence ADE and ADE-(G)XL

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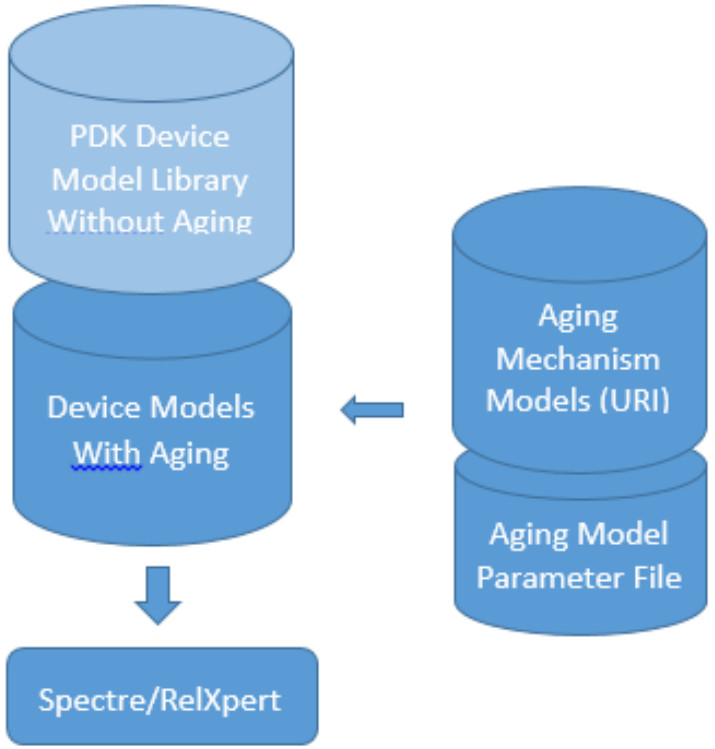
Modular Approach for Aging Model Implementation



- Direct modifications in PDKs should be avoided (danger of inconsistency if PDK is updated)
- Models for aging mechanisms to be added optional as external modules
- Modules should be applicable to different PDKs of different vendors (➔ aging model library process independent)
- Parameterization of the models at vendor data

Experiences with Aging Simulation
Status

- Aging models available for CMOS/HVMOS; PBTI, NBTI, HCI
- Aging simulation could explain observed spec violations, especially regarding mismatch
- Accepted by designers and integrated in design flow (ADE-(G)XL), if supported by PDK vendor

- Obstacles
  - Aging data acquisition
  - Accuracy (e.g. recovery effects not modelled, incomplete consideration of mission profile)
  - Software Issues
    - Incompatibility (version change)
    - Implementation bugs
    - Incomplete documentation