Embedded Computing in the Nano-era

An Industrial Perspective

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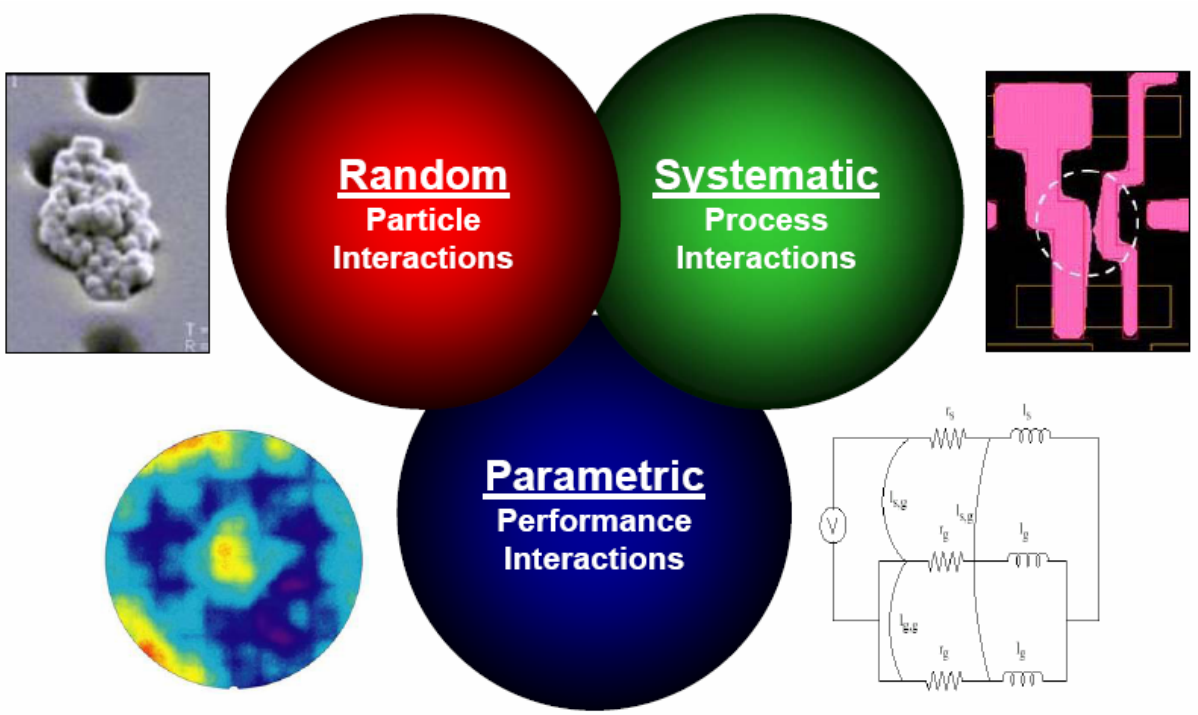
Design and Manufacturing Get Coupled

- In the good old times, design and fab were reasonably separated issues. Not anymore!
  - OPC, signal integrity, leakage, etc.
- At 65nm and beyond chip area becomes

  (Wafer area) / (# of working chips)

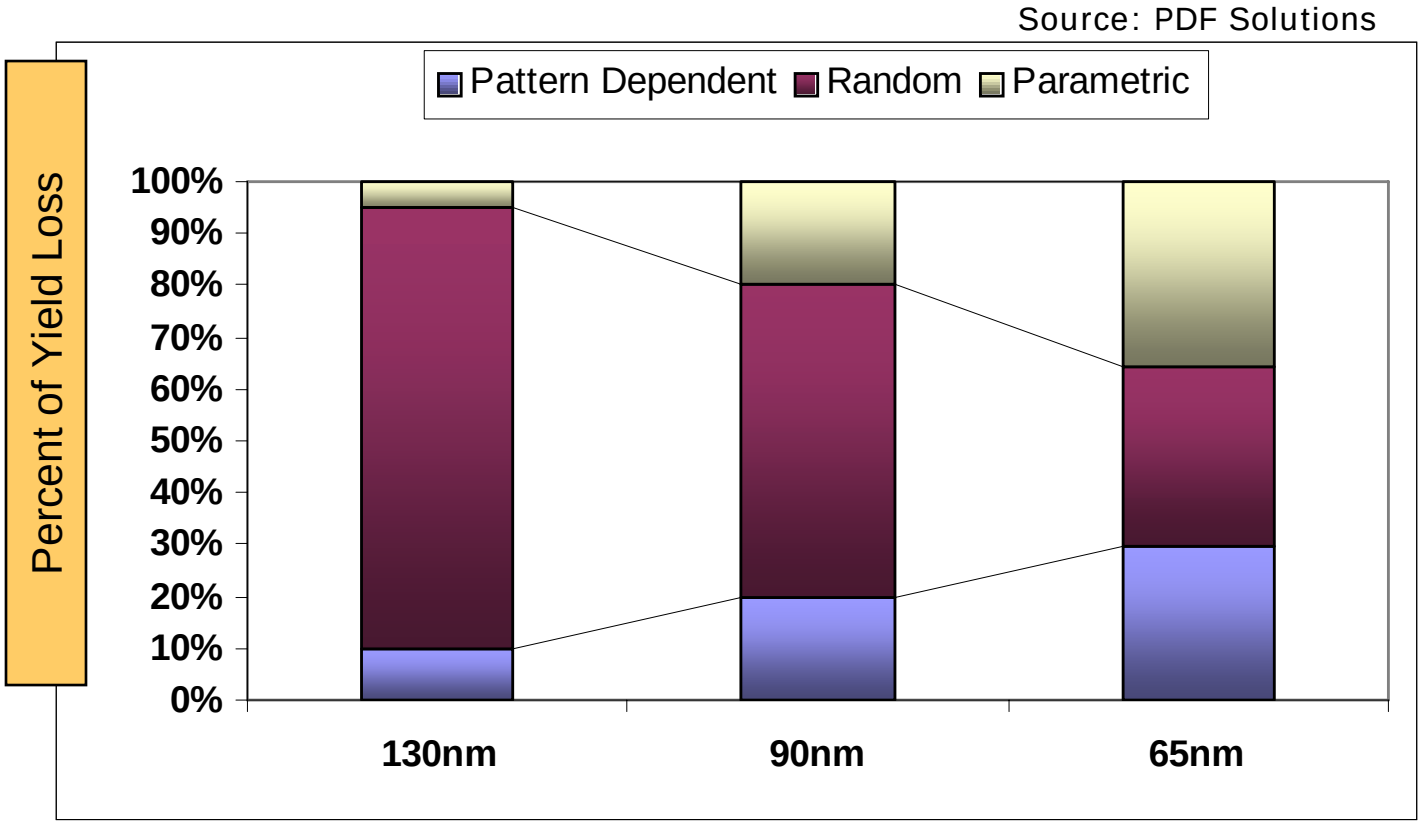
  where *# of working chips* depends on design too!



Yield Trends

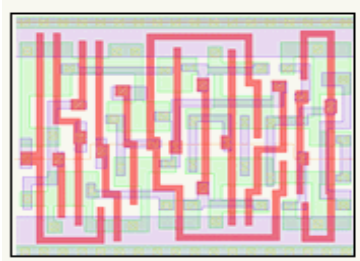
- Parametric and pattern dependent variations beginning to dominate yield for typical products

Source: PDF Solutions

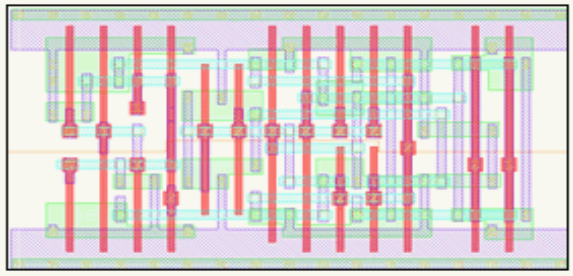


Regularity to Recover Manufacturability

- Regularity at layout level becomes a necessity for manufacturability
  - Fabrics concept: very few, optically regular structures that guarantee DFM



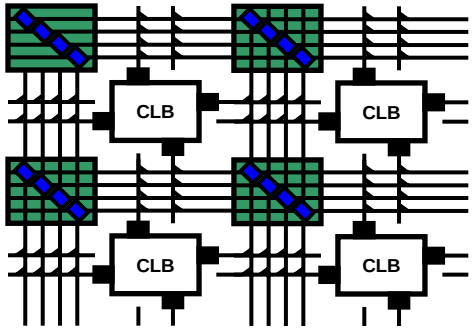
Classic Standard Cell



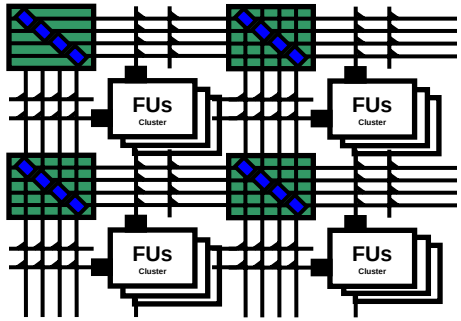
Highly Regular Standard Cell

- Very few litho-friendly cells
- Aggressive design rules
  - Minimal area penalty
- Area cost recovered thanks to more regular interconnect

- Scaling up regularity for DFM
  - Reconfigurable logic
    - Of various kinds
  - Reconfigurable data-paths



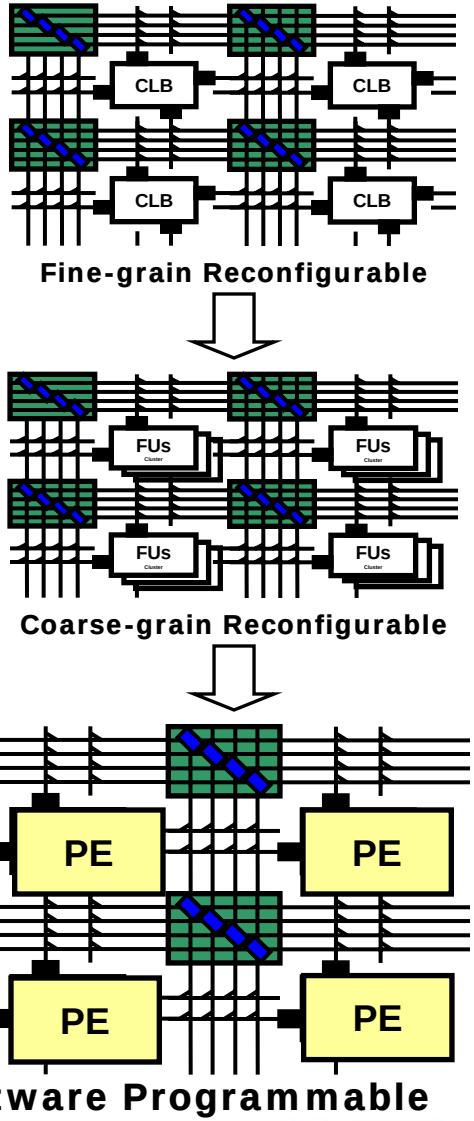
Fine-grain Reconfigurable



Coarse-grain Reconfigurable

Strong Complexity/Economical Pressure Towards Software Programmability

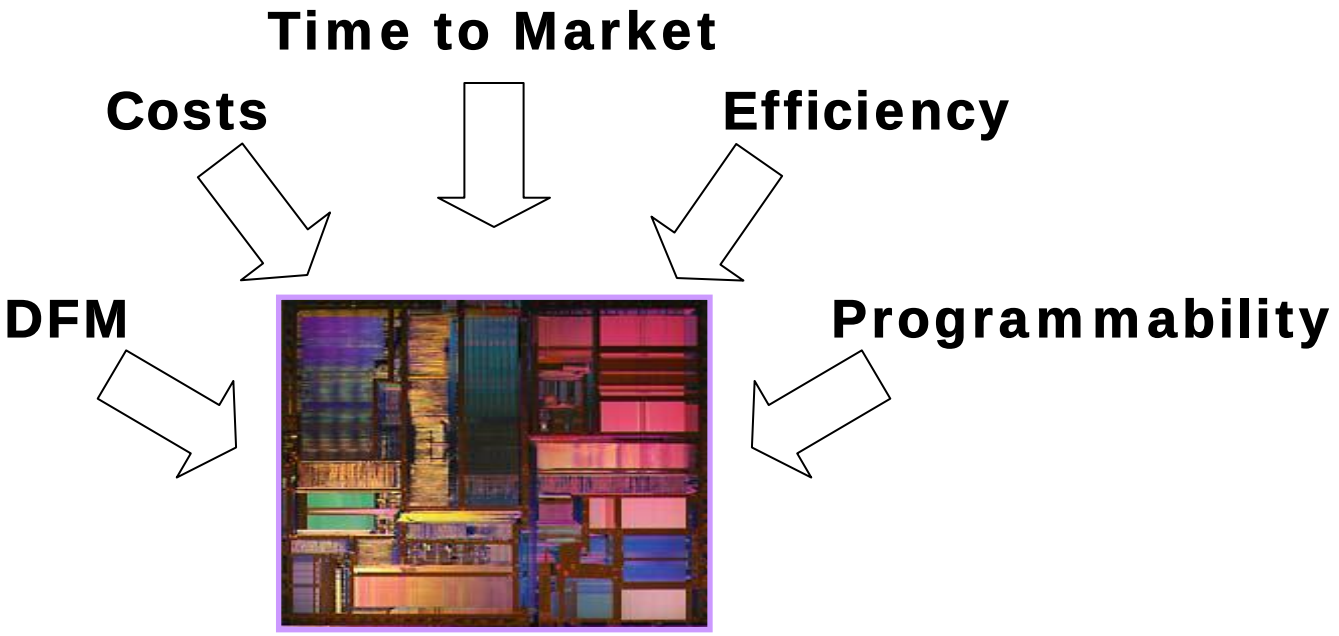
- DFM helps, still…
  - Cost of lithographic masks keeps increasing exponentially
    - Worth it only for huge volumes
  - Large, complex, multi-function chips
    - Very long design/verification times
    - Very large investments
  - Hardwired functionality too risky
    - Incompatible with the long development times
      - Spec's evolve faster…
    - Too short life-cycle
  - Very strong pressure towards Software Programmable solutions



Yes, BUT… Not So Easy: Some Raw Numbers…

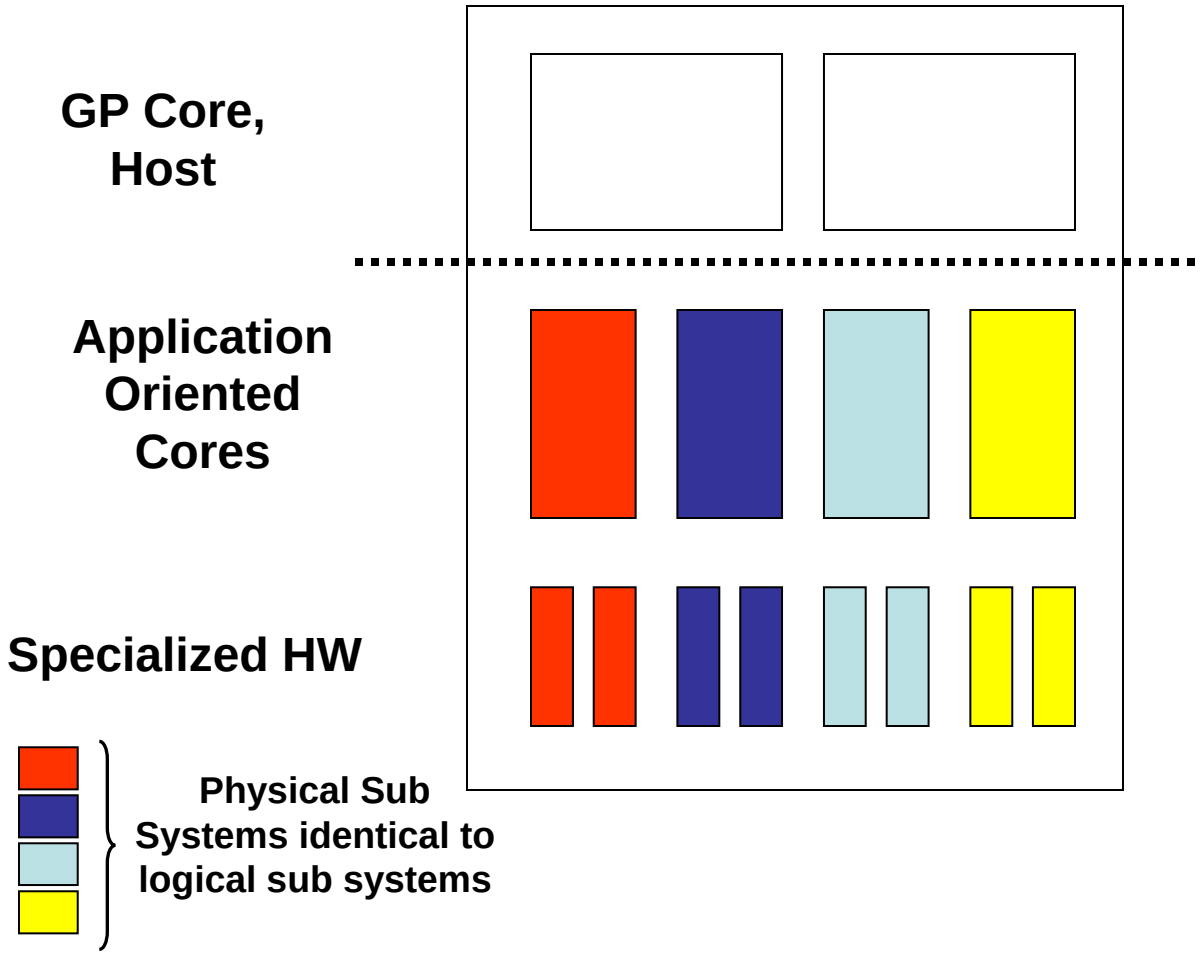
- Already outdated numbers
  - Video, H264 encode (HD 720p, 30fps)
    - Hierarchical motion estimation: 25 to 160 GOPS
    - Video pipeline coder : 8 GOPS
    - Bit stream processor: 8 GOPS
    - Deblocking filter: 8 GOPS
  - Digital TV
    - 2004: 9000 Ops/Pixel -> 450 GOPS
    - 2008: 18000 Ops/Pixels -> 900 GOPS
  - Graphic:
    - OpenGL 1.0 -> 140 Ops/Pixels -> 3.8 GOPS (HD 720p, 30fps)
    - OpenGL1.1 -> 240 Ops/Pixels -> 6.6 GOPS (HD 720p, 30fps)
    - OpenGL2.0 -> 400 Ops/Pixels -> 11.05 GOPS (HD 720p, 30fps)
  - Audio:
    - 800 MIPS
- Today: Full HD, 3G, 12MPixel
- Tomorrow: Quadruple HD, 4G, 20MPixel
- And on and on… (ultra-high definition “walls”)

Increasingly Challenging Times Ahead…



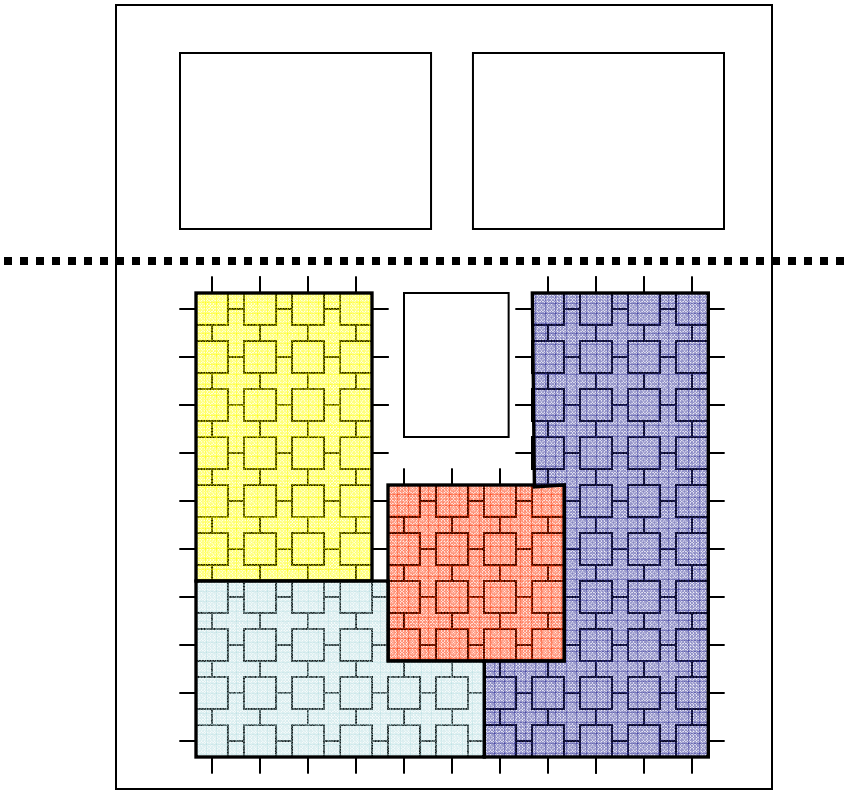
- Very difficult to find right mix of solutions
  - Several moving targets: technology, market
  - Huge costs involved: cannot get it wrong…

How It Could Look Like

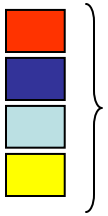


How It Could Look Like

GP Core,
Host



Data Flow
Intense Fabric



Logical Susbsytems
are now really logical!

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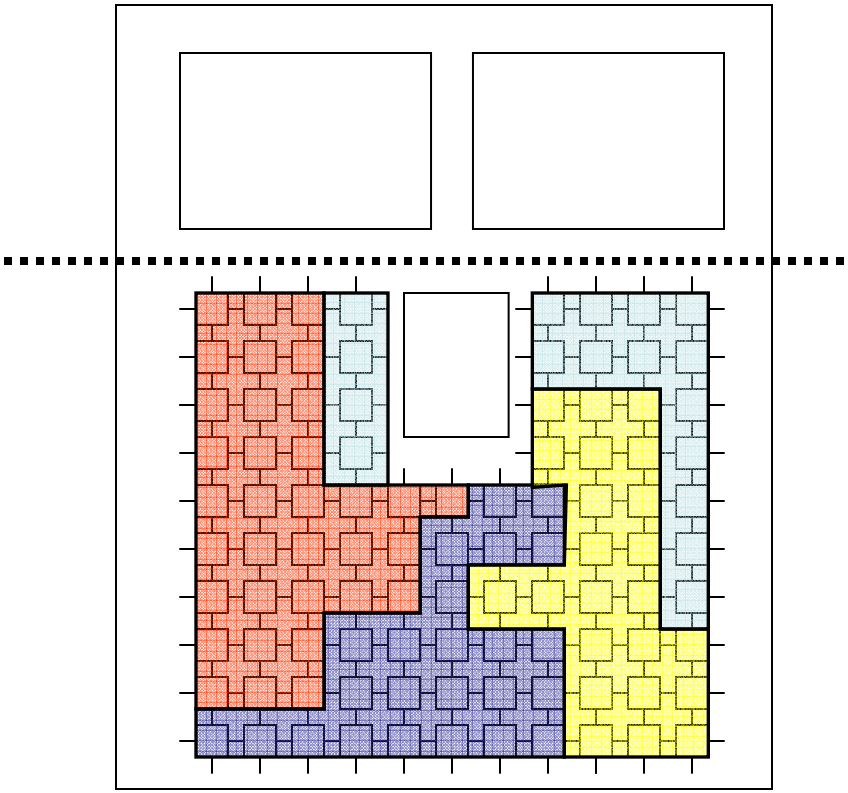

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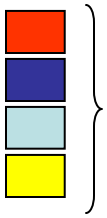
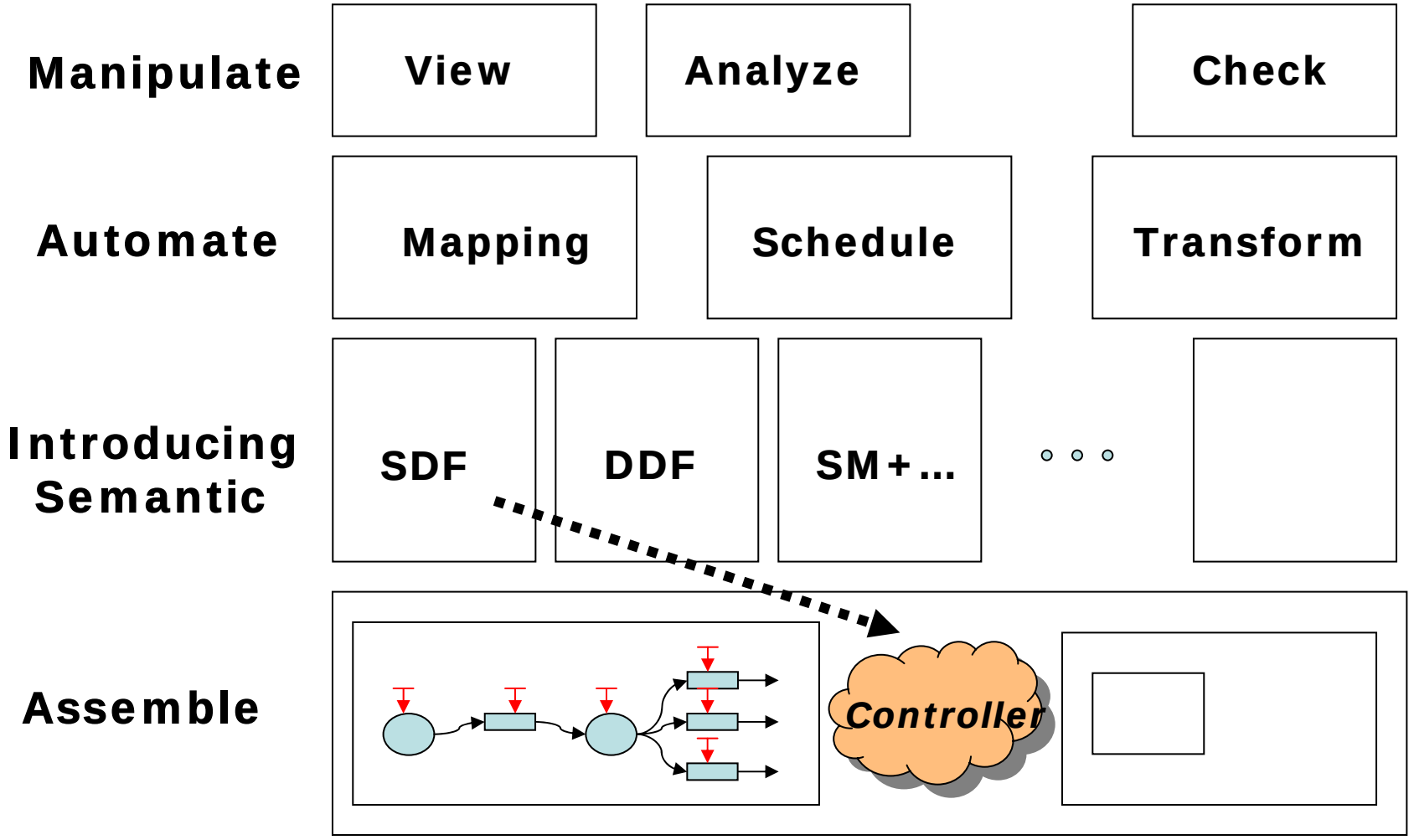


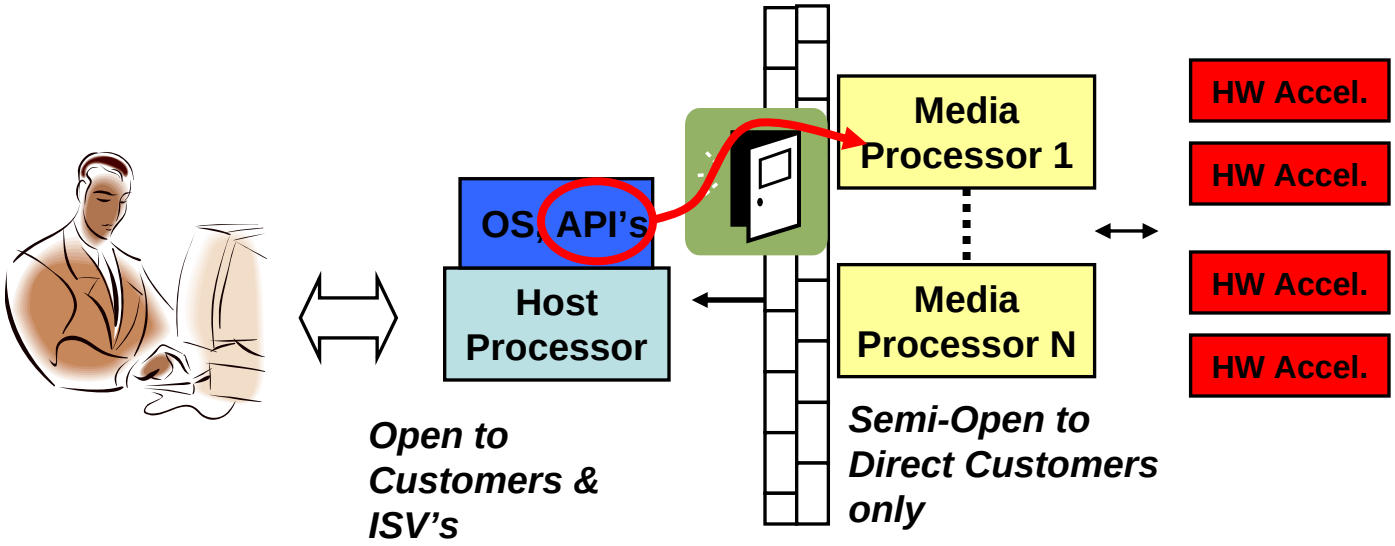
Logical Susbsytems
are now really logical!

- Run-time reconfigurable NOT optional!
  - It makes it viable, compared to H/W

What About Programming…

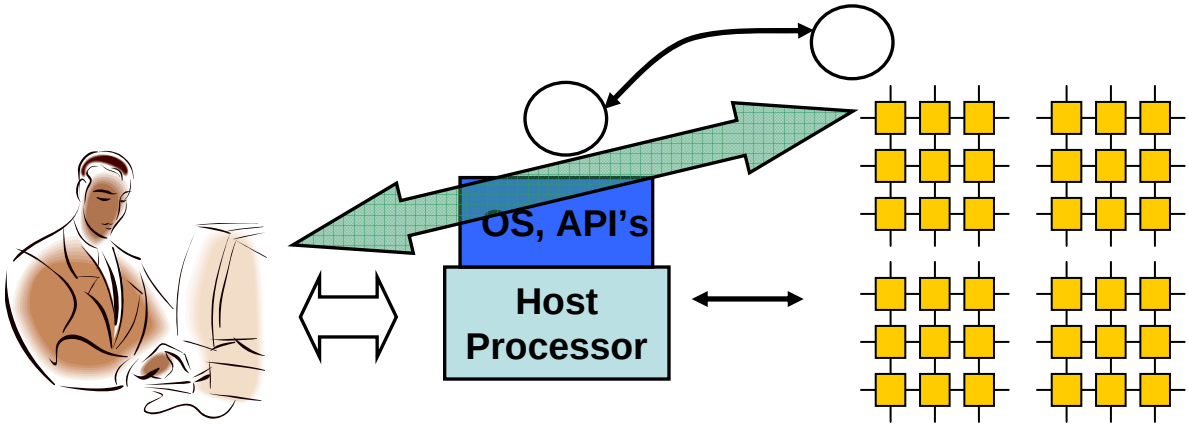


Today Platform Is Mostly Closed



- Very restrictive model
  - Little computational power
  - Little differentiation

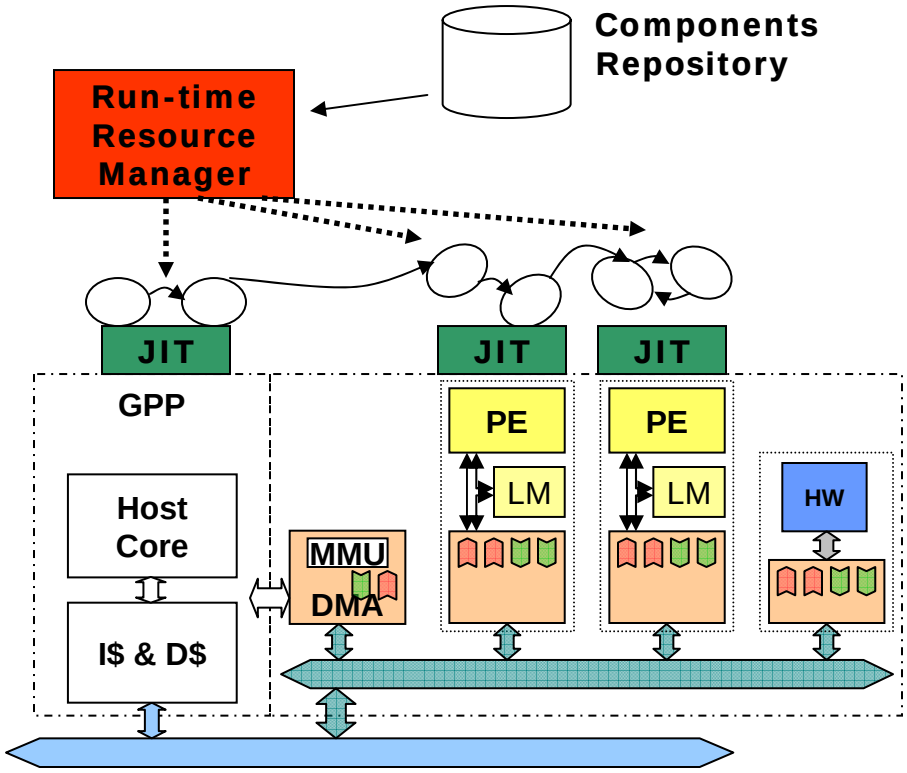
Tomorrow Platforms Must Be Open



- Looks familiar… like GP-GPU today
- HUGE computational power available for rich set of applications
  - Man-Machine Interface?

Yes, but How?

- Gradually… ☺
- Foundations: mix of
  - Component-based programming
    - Heterogeneous MPSoC Programming Model
  - Processor Virtualization
    - No fragmentation for S/W developers
    - Freedom for platform providers
- Result is whole platform virtualization, i.e.



Truly open platform!

Conclusions

- Embedded computing in the nano-era will be tough…
- But also full of very motivating challenges
  - We are going to bring all the computer science knowledge, including HPC, into embedded chips
  - Leverage from there to find innovative solutions for
    - Building massively parallel programmable and reconfigurable subsystems
    - Program them
- We will put supercomputers in the hands, cars and leaving rooms of consumers, resulting in
  - Very realistic multi-media rendering
  - Increasingly sophisticated man-machine interaction

Thank You!