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Archive



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## Mega trends & advanced packaging are reshaping the ways of testing systems

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Mesa, Arizona • March 3 - 6, 2019



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- Opportunities for advanced packaging, Why? Where? How
- Stacking technologies:
  - 2.5D & 3D stacking technologies
  - Market segmentation
  - High End segment: requirements, examples, supply chain & test
  - Stacking in CIS
- Challenges
- Conclusions



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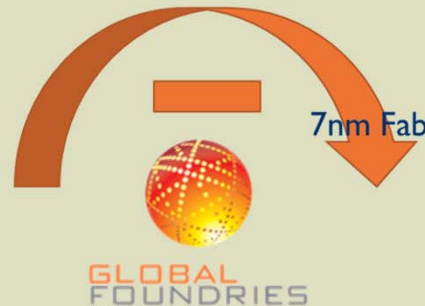
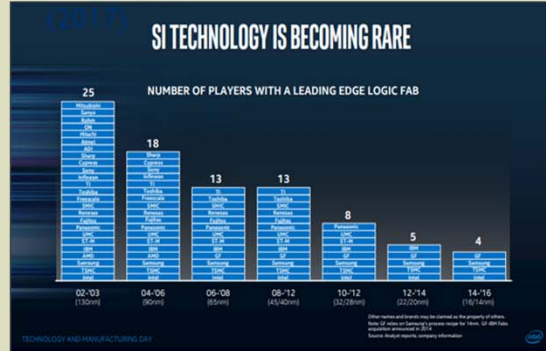
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## Why advanced packaging is become more & more important ?

- Moore's law slowing down

Only 4 players with 14/12nm Fab



Only 2-3 players still in the 7nm node race

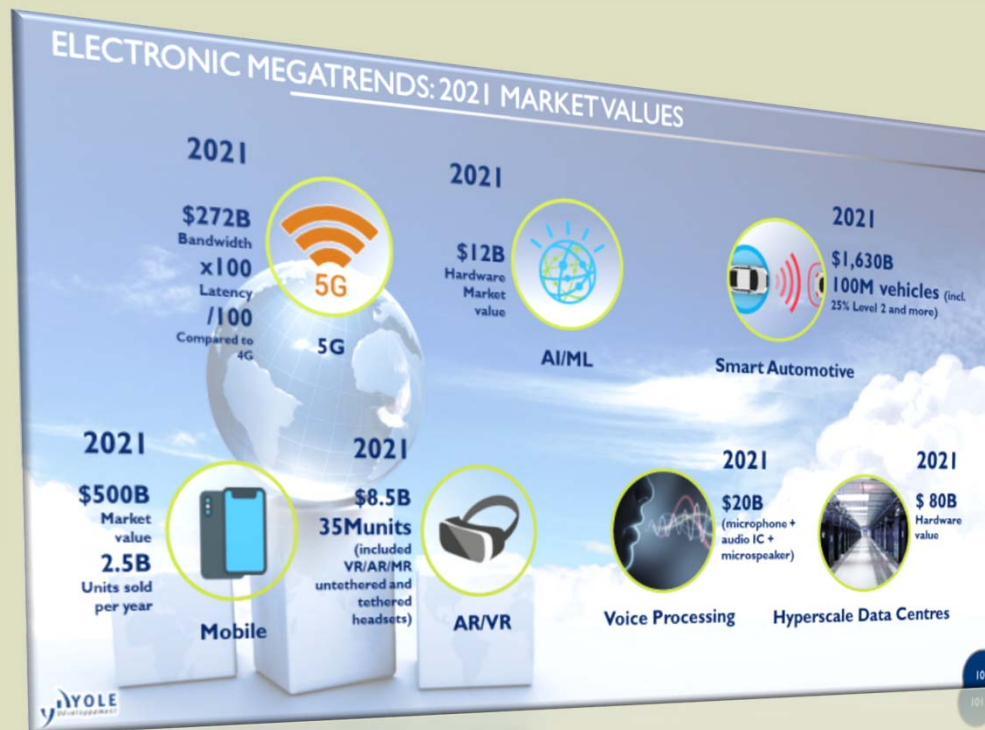


Delay in Intel's 10nm node, so obviously they are late regarding TSMC & Samsung

- Advanced packaging technologies like TSV, hybrid bonding, Fan Out... are one alternative to Moore's law slow down

MI1

## Electronic mega trends - REQUIREMENTS



- More computing power
- High speed
- More bandwidth
- Low latency
- Low Power
- More functionality
- System integration
- More sensors
- More memory
- Low cost
- Hardware-software compatibility

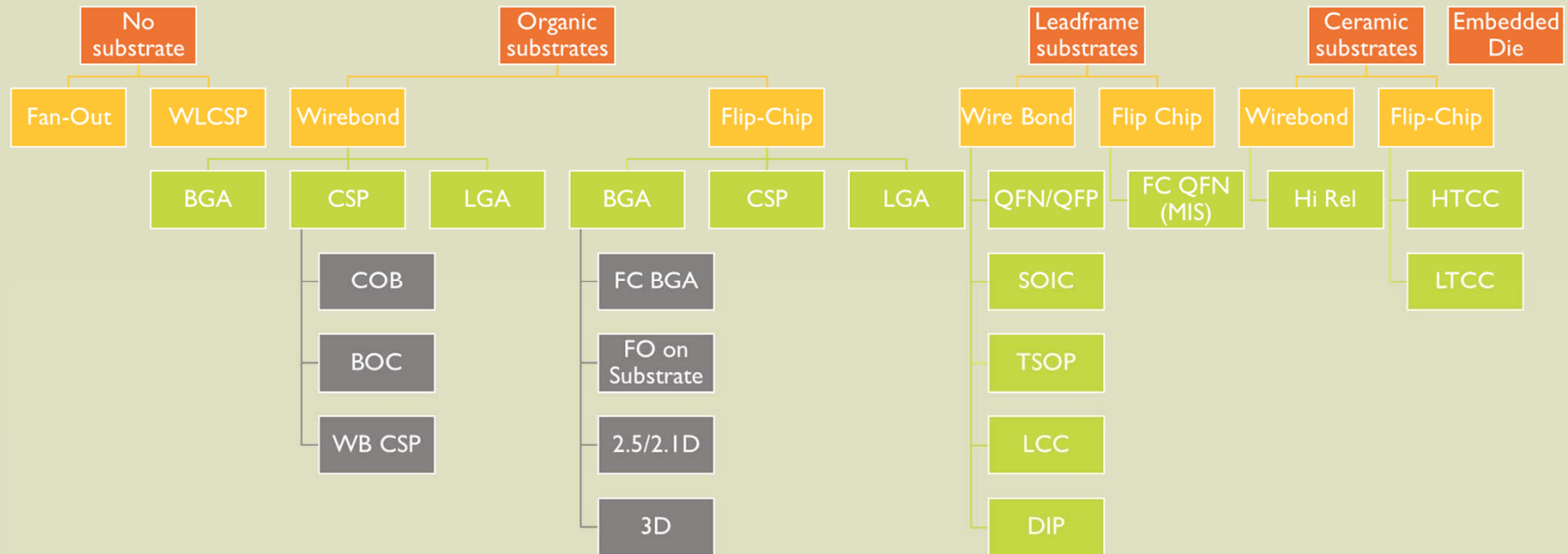


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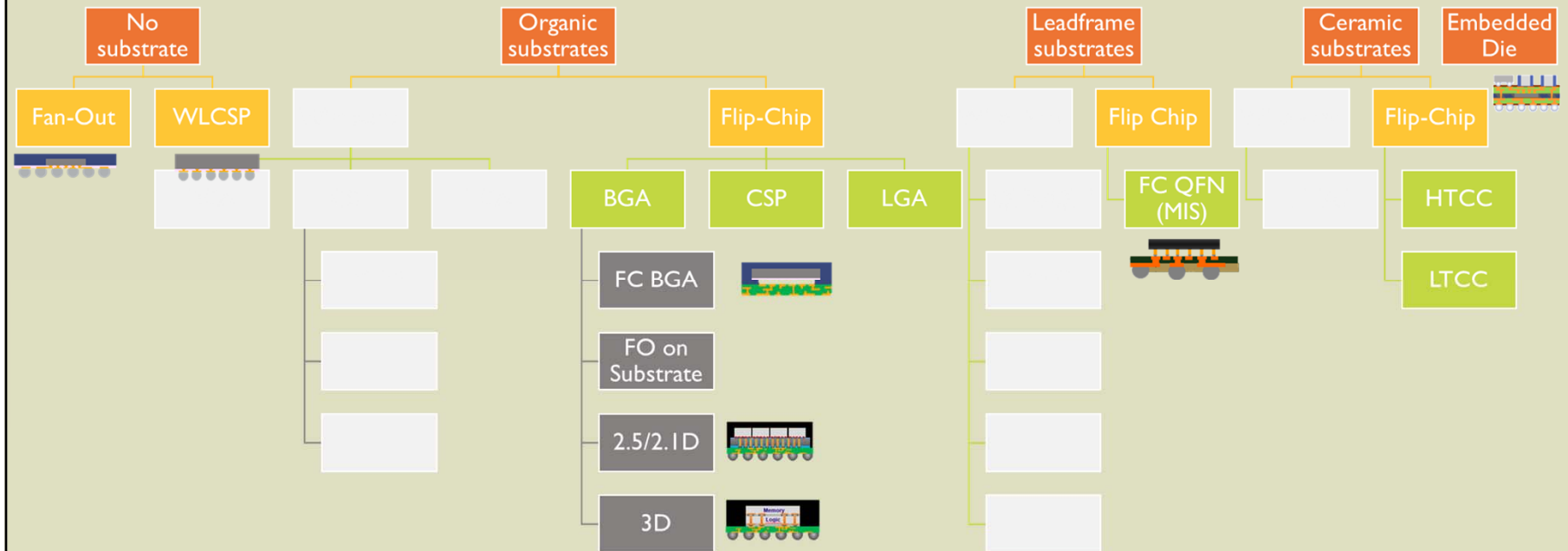
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## Packaging platforms

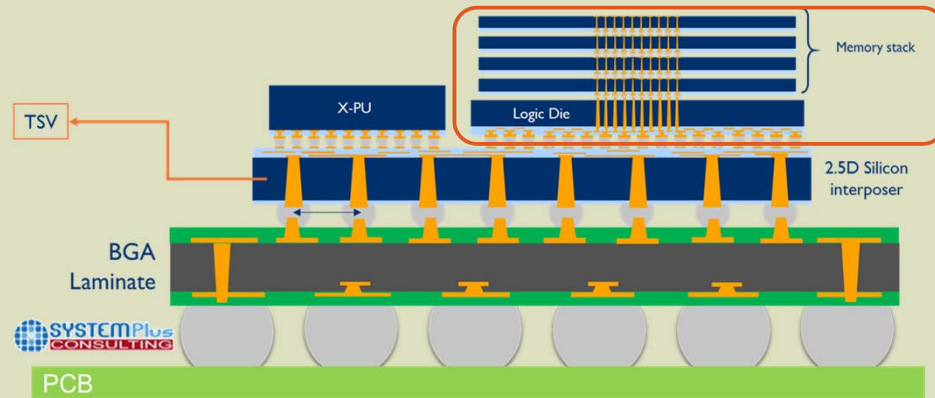


## Advanced packaging platforms

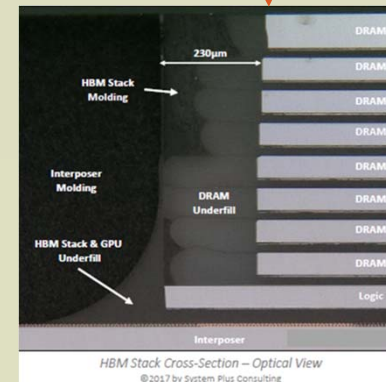




## 2.5D & 3D stacking, packaging technologies



DRAM 3D stacking  
→ High Bandwidth  
memory (HBM2)



- Heterogeneous integration
- High performance packaging technology
- For high end markets as data centers, clouds ...

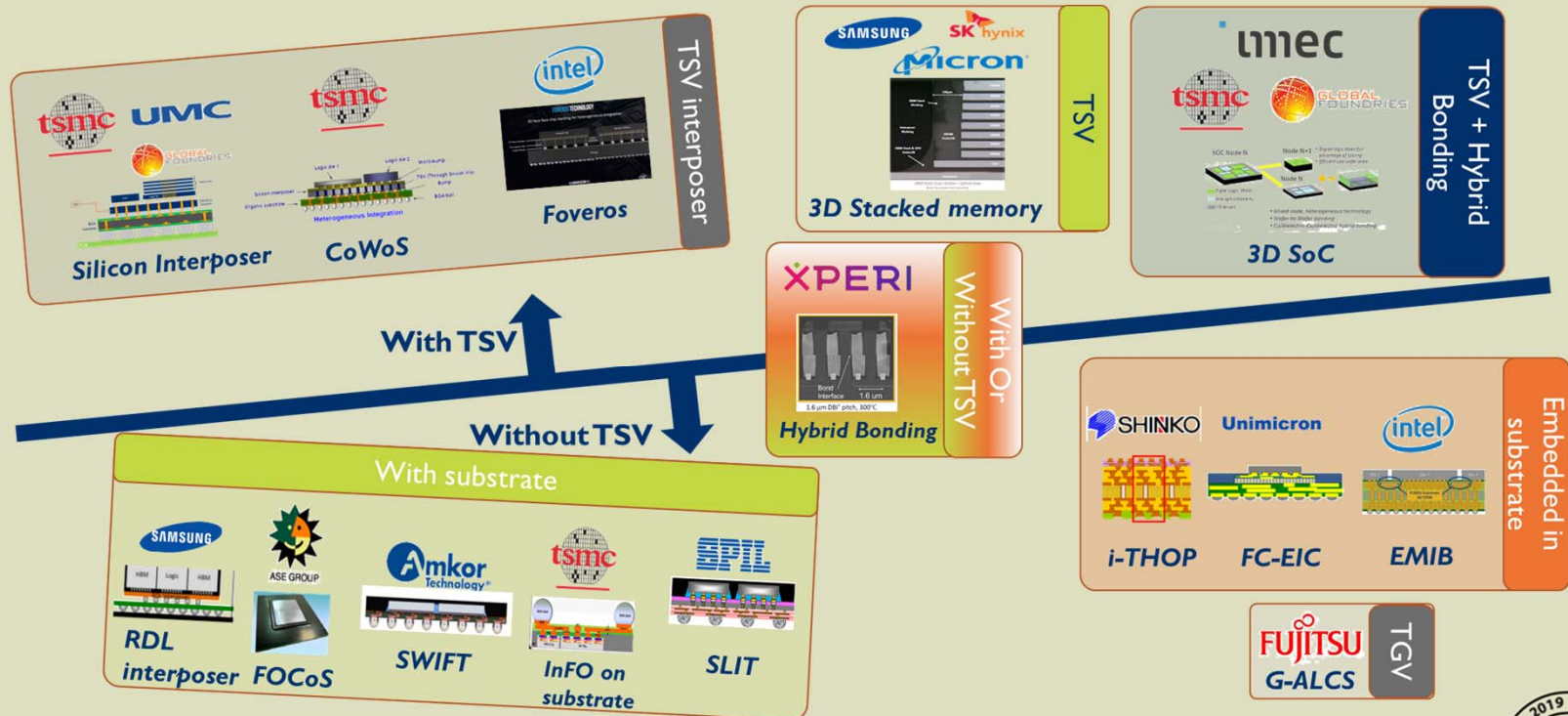


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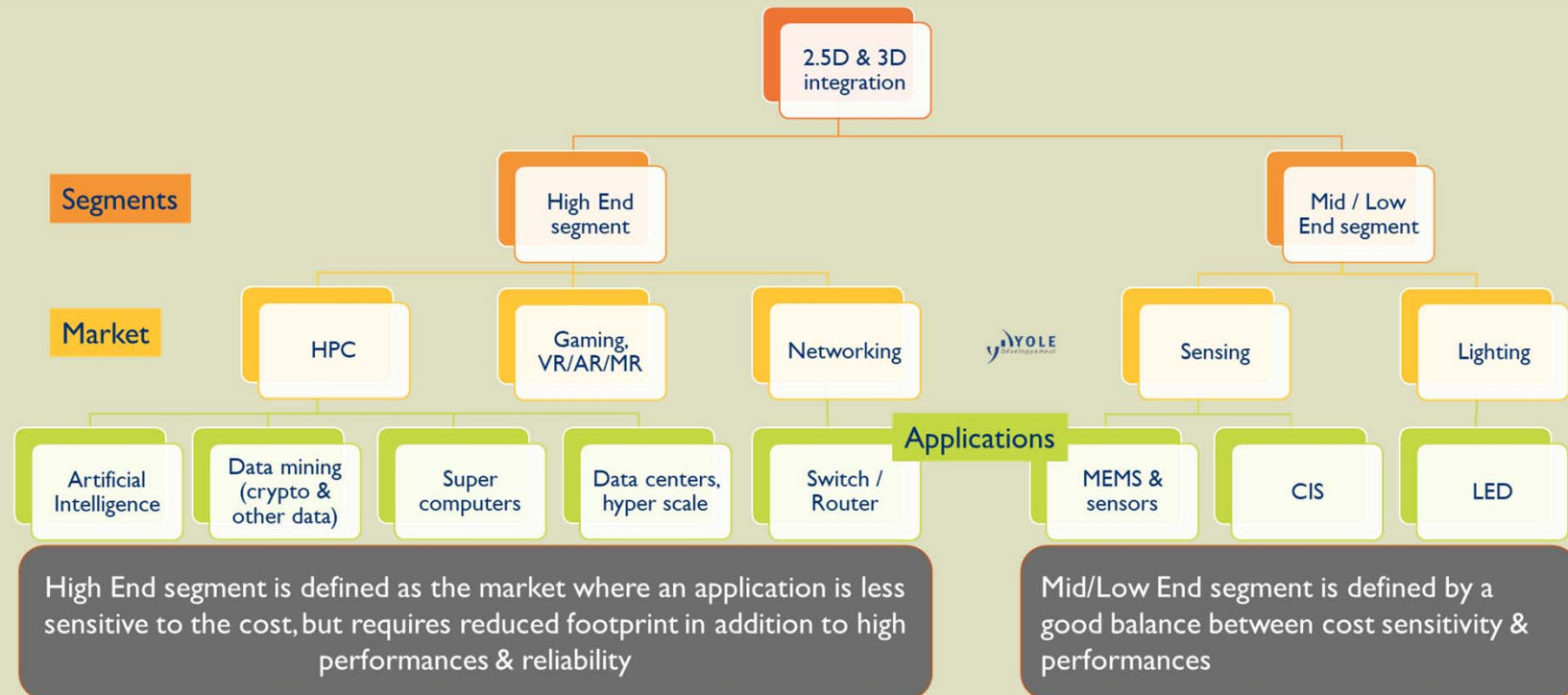
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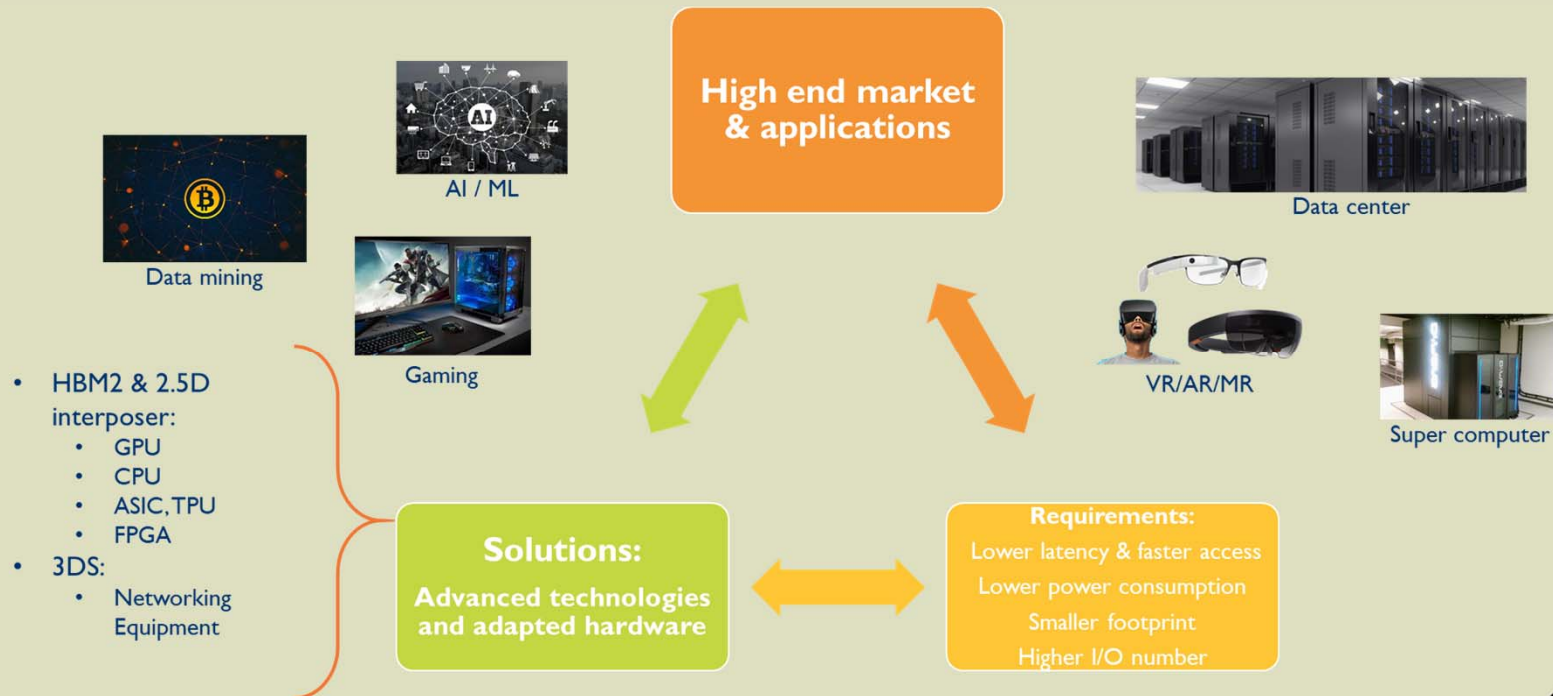
## 2.5D & 3D stacking technologies With / Without TSV. Foundries VS OSATs battle



## 2.5D & 3D integration Market segmentation



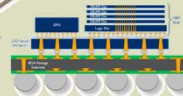
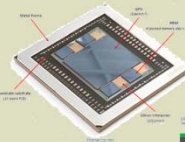
## 2.5D & 3D stacking technologies are the answer for high end segment market



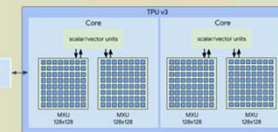
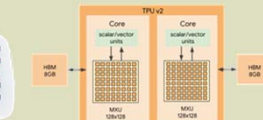


## Some hardware examples for high end segment using stacking technologies

- AMD & Nvidia GPU:
  - 4 or 8GB HBM2 (1 or more physical HBM2 dies)
- Xilinx FPGA Virtex Ultrascale+:
  - 16nm technology
  - 4 or 8 GB HBM2 memory (1 or 2 physical HBM2 dies)
  - Up to 460 GB/s of bandwidth
- Broadcom Jericho2: switch/router
  - 1 HBM die
  - Jericho2 ASIC
  - HBM & Jericho interconnected via the Si interposer
- Google TPU (AI neural-network computing accelerator):
  - TPU2:
    - 64GB HBM2 & 180Tflops
  - TPU3:
    - 128GB HBM2 & 420 Tflops
    - Liquid cooled TPU



HBM2



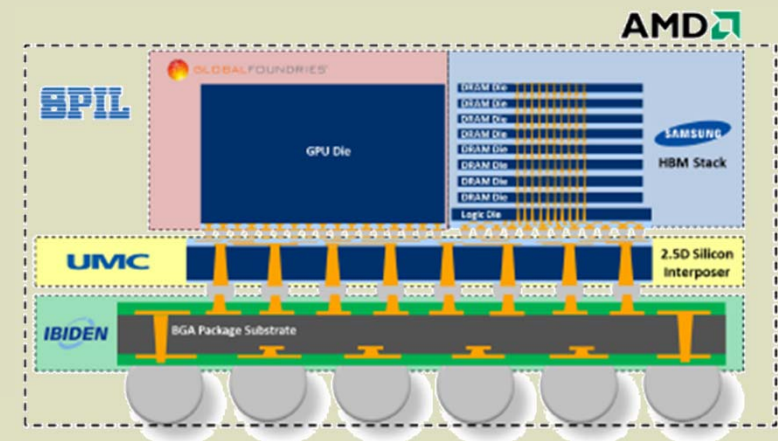
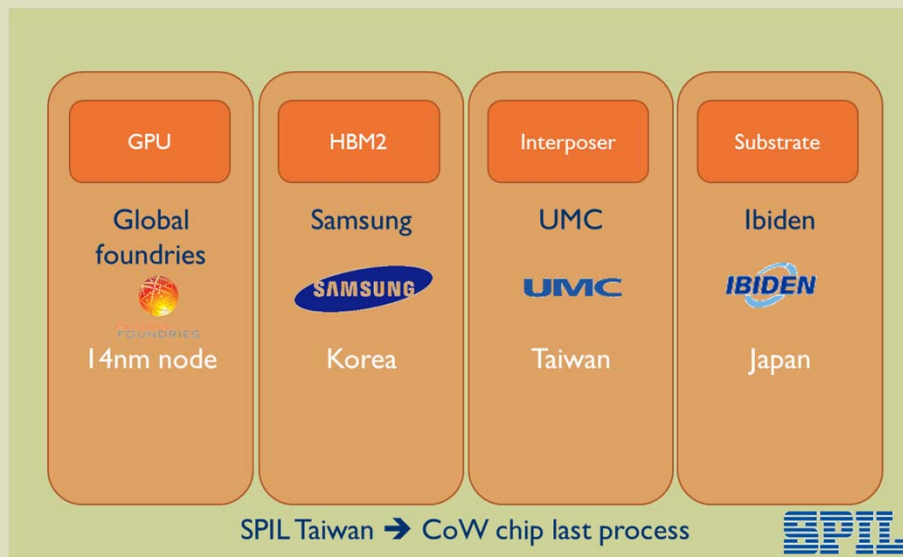
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## An example of the supply chain for 2.5D packaging technology

- Supply chain for AMD Radeon Vega Frontier GPU
- Components from 4 companies + 1 OSAT



Yield has a direct and major impact on the ASP (Average Selling Price)



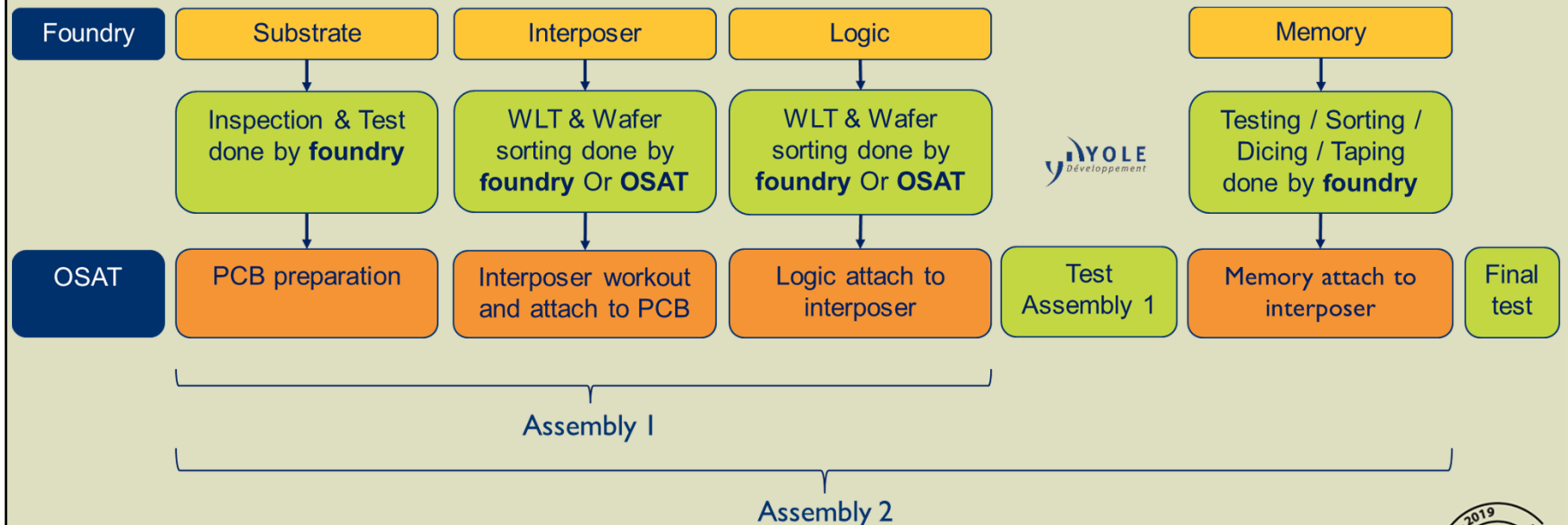
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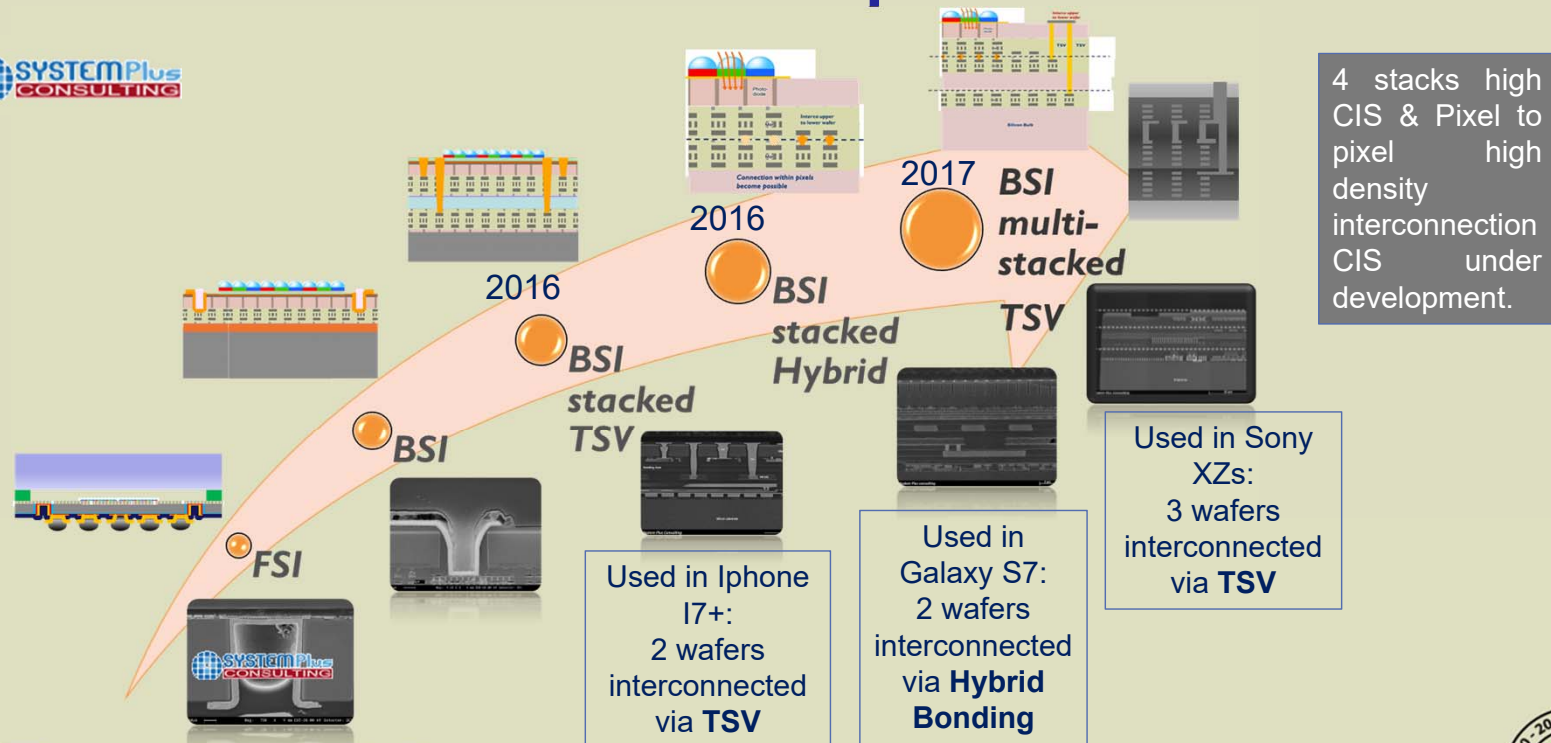


## 2.5D simplified process with test steps

- At least 6 test steps
- $Yield_{Combined} = Y_{Substrate} * Y_{interposer} * Y_{Die1} * Y_{Die2} * \dots * Y_{DieX}$



## Stacking in CIS, technologies evolution & Roadmap



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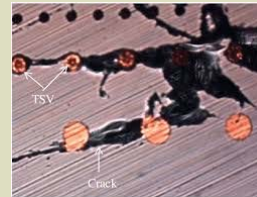


## New challenges induced by stacking technologies

- Thin wafer handling:
  - 100µm wafer thickness to handle → White paper thickness
- Bow management:
  - Alignment difficulties
  - Probe testing difficulties
  - Cracks induced by vacuum on tester/prober
  - Cracks induced by probing with Bow
- Test difficulties:
  - Specific test structures need to be implemented (E-fuses in Si interposer for example)
  - Difficulties to test small Cu micro bumps → Larger test pads & additional test paths needed (design rule)
- Burn In test:
  - Complexity to identify the origin of a failure occurring at the system level with different devices & layers
  - Reliability is crucial for some markets as automotive



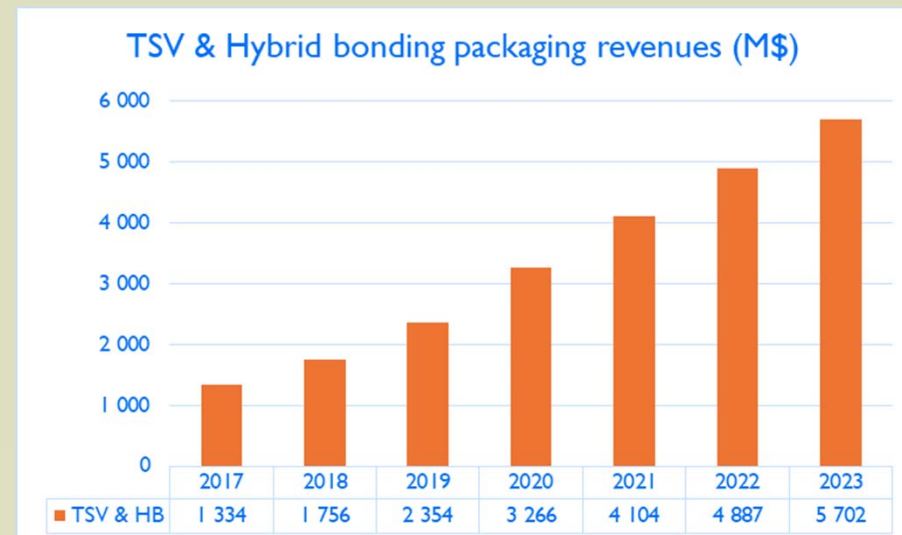
Source: Fraunhofer IZM



Source: Research Gate

## TSV & Hybrid bonding, packaging revenues

- Stacking technologies based on TSV or Hybrid bonding considered
- **\$5.7B** packaging revenues for stacking technologies in **2023**



## Conclusions

- Stacking technologies = one solution to Moore's law slow down
- Stacking technologies are widely used in high end markets but are also present in Mid/low end applications
- \$5.7B stacking technologies, packaging revenues in 2023
- TSV is the dominant technology but is being challenged
- Yield is important when talking about ASP
- Test is a crucial, complex & challenging step of the process
- Reliability test is important for advanced packaged systems, especially when related to stringent markets as automotive



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