

INTEGRA
TECHNOLOGIES
An Employee Owned Company

Challenges with CHIPS Act

CMSE Conference, Los Angeles
April 26, 2023

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INTEGRA TECHNOLOGIES



CELEBRATING 40 YEARS IN BUSINESS IN 2023

DMEA TRUSTED FACILITY

LARGEST OSAT REMAINING IN THE UNITED STATES AND ONE OF THE ONLY DOMESTIC DOD PROVIDERS OF THESE SERVICES (100% U.S. OWNED AND OPERATED)

SIGNIFICANT EXPERIENCE AT OFFSHORE VOLUME MANUFACTURING WITHIN THE COMPANY

480 EMPLOYEES: 237 EMPLOYEES – WICHITA, KS, 240 EMPLOYEES – MILPITAS, CA

EMPLOYEE-OWNED COMPANY (ESOP)

500+ ACTIVE CUSTOMERS FROM AVIONIC, MILITARY, AEROSPACE, MEDICAL, AUTOMOTIVE, COMMERCIAL AND INDUSTRIAL SECTORS (70% A&D)

SERVICE 14 OF THE 16 CRITICAL INFRASTRUCTURE SEGMENTS

CUSTOMER SATISFACTION RATING OF 97%

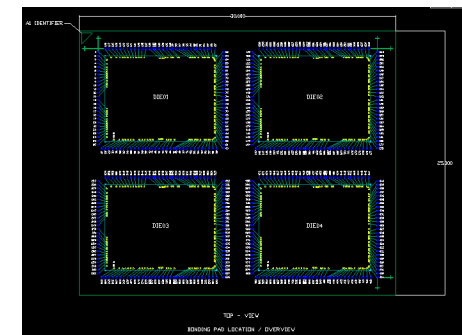
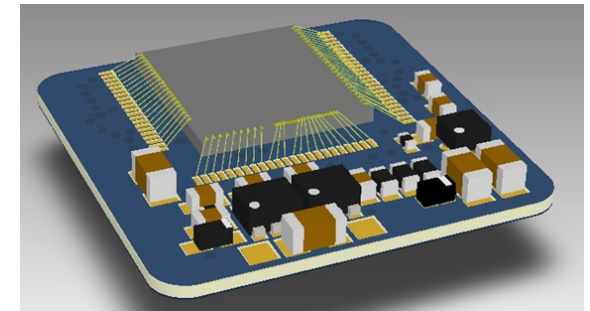
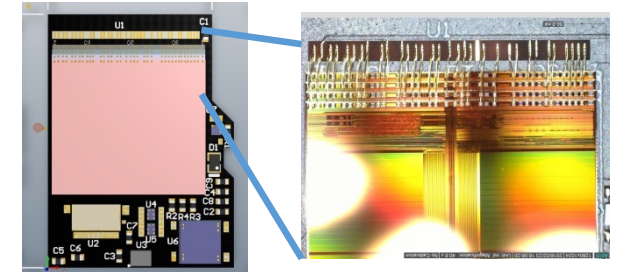
DMEA Category 1A Trusted, Single-Source Turnkey Solution from Wafer Processing to Final Test

 Die Prep	 Packaging & Assembly	 Advanced Packaging & Assembly	 Electrical Testing (purchase parts, inventory BOM mgmt.)	 Qualification & Reliability	 DPA & FA
Wafer Thinning & Polishing: Down to 25 microns	Standard IC Packages: Plastic Hermetic & Ceramic; QFN & DFN; Flip Chip; Ball Grid Array (BGA)	System-in-Package (SiP): design & assembly	Total Test Solution: Test Software & Hardware (load boards, probe cards, handler interface) Development	Plastic Encapsulated Microcircuit (PEM) Qualification	Laser Ablation for advanced decapsulation of Copper & Silver Bond Wire ICs
Wafer Dicing: Fully automated Disco systems handle wafers up to 300mm	Die-Attach: non-conductive & conductive Epoxy; Eutectic Solder; Silver Glass	Multi-Chip Module (MCM): design & assembly	Device Characterization & Upscreening: -55C to 200C	Qualifications: HTOL & LTOL; HAST; Temperature Humidity Bias Life (THB)	Destructive Physical Analysis (DPA): Mil-Std 1580
Dice Before Grind (DBG): For singulating die when normal sawing creates chipping and edge damage	Interconnect: Flip-Chip Bond; Gold Ball Bond; Gold Wedge & Aluminum Wedge Bonds	BOM Selection: Assist in selection, sourcing and purchasing BOM	Wafer Probe: Hot & Cold Chuck	Preconditioning: Perform all JESD22-A113 Preconditioning in-house	Failure Analysis (FA): Scanning Acoustic Microscopy (SAM), Scanning Electron Microscopy (SEM)
Die Inspection: Automated and manual visual inspections to commercial, MIL-STD-883, and Medical Electronics specifications	Encapsulation: Transfer Mold; Glob-Top/Dam & Fill; Lid options; Lid Seal options	Program Management: New package introduction to technology transfer to large volume offshore factories	Test Program Library: >18,000 programs to leverage for cost-effective solutions	Additional Services: Burn-In Test; Temperature Cycling; Thermal Shock; Autoclave; Seal Test	Additional Services: Particle Impact Noise Detection (PIND); X-Ray Fluorescence (XRF); Fine & Gross Seal Test

SiP/HETEROGENEOUS INTEGRATION



- **Experience from Development through Delivery including:**
 - Parts & Substrate Procurement
 - Testing & Reliability and Development
 - Complex Assembly
- **Extensive System-In-Package (SiP) Assembly Experience**
 - Military, Medical, and Commercial Customers
- **Complex Multi-Die/Multi-Component SiP Assembly-uSDcard**
 - 4-Stacked Micron 32G NAND, Silicon Motion Controller, TI Multi-Func Gate
 - Microship Reset Monitor, Atmel Attiny 85 Microcontroller, etc.
- **Complex Multi-Die/Multi-Component Hybrid Assembly**
- **Multi-Die Space Level Hybrid Assembly**
- **4 Flip Chip Die/Multi-Component 1956 Ball BGA Assembly**
- **Die Extraction and 4DHSiP™**



NOFO (Notice of Funding Opportunity)



- **NOFO released on Feb 28,2023**
- **Somewhat watered-down requirements for on-shore packaging:**
 - Vision Statement: The industry distinguishes between two categories of packaging: conventional and advanced. Although the United States must on-shore some conventional packaging for national security purposes, it will generally be difficult to build economically competitive conventional packaging facilities in the United States.
 - Pg 14. Need to highlight USA focused supply (front and backend).
 - The Department is therefore seeking to invest in projects that meaningfully increase U.S. semiconductor production and strengthen U.S. and allied supply chains, with a particular emphasis on projects that will mitigate risks from supply chain shocks associated with the geographic concentration of current semiconductor production. **To best support supply chain resilience, projects should generally be capable of continued operations for a period of time without access to non-U.S. facilities and personnel.**

DoD Supply Chain Vision



- **Vision: “DoD will obtain and sustain guaranteed, long-term access to measurably secure microelectronics that enable overmatch, increased operational availability, and support Warfighter combat readiness”**
- **High-level assessment of vision**
 - Clear
 - Succinct
 - Memorable
 - Overall, well thought out

Barriers, Gaps, and/or Challenges to Achieve Vision

Challenges to Achieve Vision



- **“Obtain and sustain guaranteed, long-term access to measurably secure microelectronics”**
 - Sustaining guaranteed, long-term access is very challenging given DoD volumes & buying practices
 - High-level points (more about each later)
 - Obsolescence/DMS
 - Current practices are not in alignment with this vision
 - DoD should define advanced packaging & where the pain points are
 - Too many definitions of AP will result in reduced vision attainment
 - Majority of packaging issues are not Advanced Packaging regardless of how much publicity advanced packaging receives, particularly around the CHIPS legislation; today’s problem is vanilla
 - QFN, BGA, FCBGA, etc. are the majority of packaging issues DoD (and commercial) faces today
 - DoD needs to get back in control of the IP
 - Failing to own the IP will doom this vision to failure – if you don’t own the IP, you can never “guarantee” anything
 - Recognize that CHIPS is not enough to fund the entire wish list
 - Generally believed that CHIPS is a down payment, but how long will it be before Congress does more?

DMS Strategy - Challenge

- **Current DMS process is not always aligned with this vision**
 - Guaranteed long-term access
 - By their very nature, building systems based on COTS is not long-term unless we change our buying strategy
 - Measurably secure
 - If Lockheed Martin, NG, or other major DiB players order ME, how hard is it to figure out that DoD is likely end use?
 - Objective 1 – “Ensure timely access to measurably secure and affordable ME technology”
 - Asking a prime to search for ME is like asking me to search for uranium
 - When they do find parts, significantly higher cost to DoD because of how it is asked and how many avenue it is asked
 - Similar to UBER Surge pricing

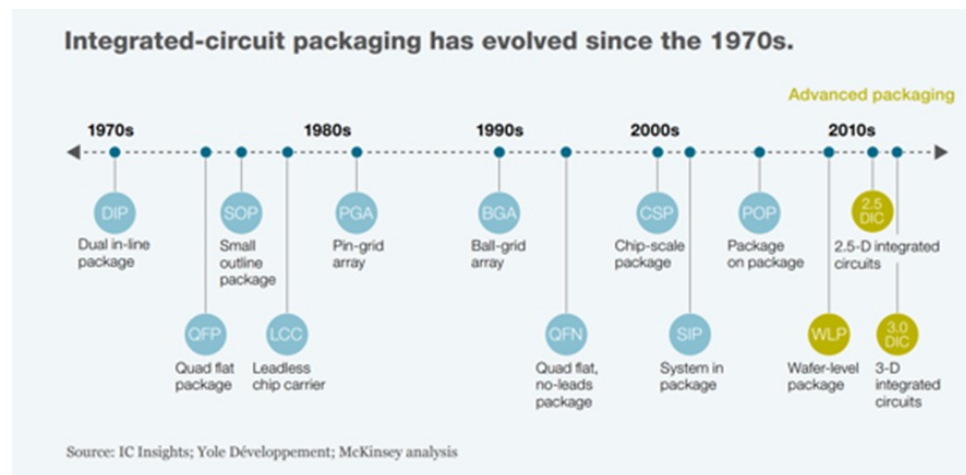
Packaging Challenge

- **Advanced Packaging vs. Vanilla Packaging**
 - Advanced packaging is the future and should be a focus
 - Argument exists that vanilla packaging can't be done in the United States profitably
 - Advanced packaging has a premium associated with it because it is new/novel, so it looks attractive
 - Vanilla packaging is the overwhelming majority of the issues DoD faces today
 - Imperative to support as many of the critical infrastructure segments as possible to fully address this
 - DoD, Space, Aerospace, Commercial, Medical, Automotive, Nuclear, Oil etc. to maintain modern equipment for vanilla packaging

Packaging Challenge

- **What is advanced today will be vanilla tomorrow**

- You can see the advancement of packaging technology since the 1970s in the graphic below and notice the time between the next generation is getting smaller
- Items in blue circles categorized today as vanilla packaging
- Do the yellow circles in the graphic below depict how DoD defines advanced packaging?
- Unless someone stops progress, 2.5D, 3D, and 3.5D packaging will be vanilla in the future
 - What happens to the premium on price when the next generation comes out? (iPhone models)



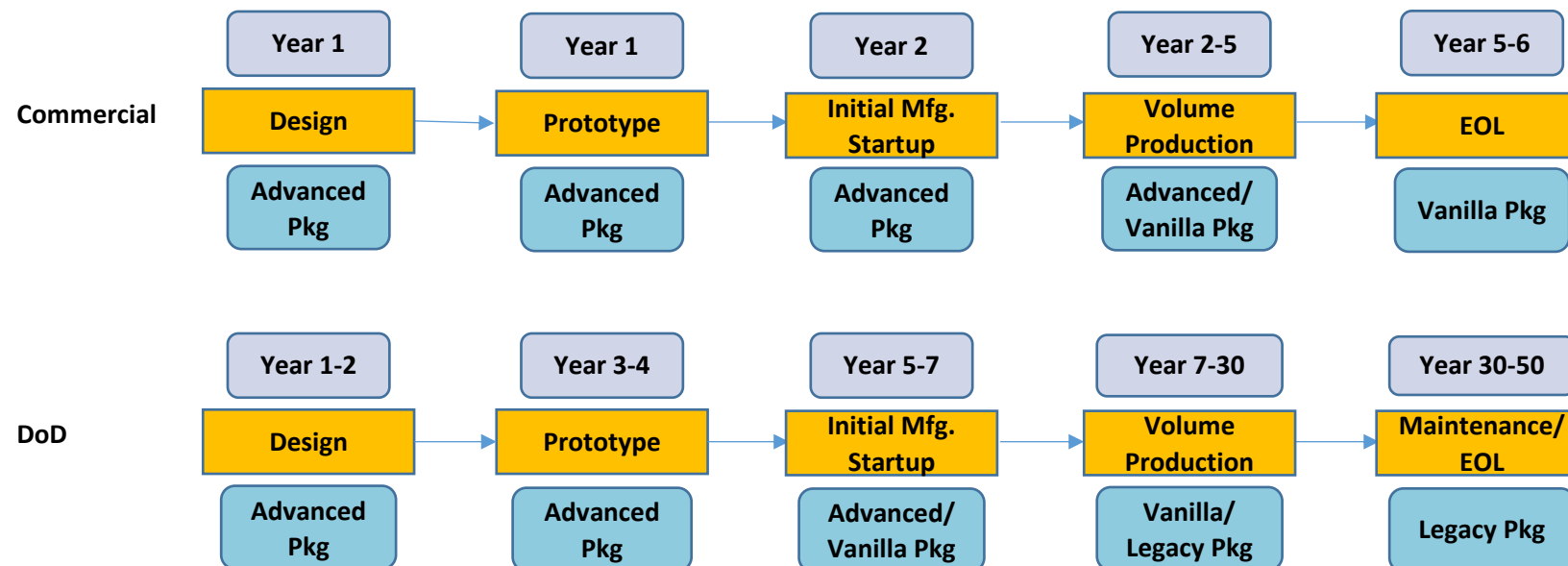
Packaging Challenge



- **What is advanced today will be vanilla tomorrow**

- We should ask ourselves - What will the next generation of people looking at DoD ME be facing?
 - It is fact that the premium associated with what is advanced packaging today will go away
 - If we have not solved for vanilla packaging today, what makes us think that what is advanced today will be built here?

Sample product development lifecycles and the associated packaging needs/why DoD is so much more complicated



Packaging Challenge

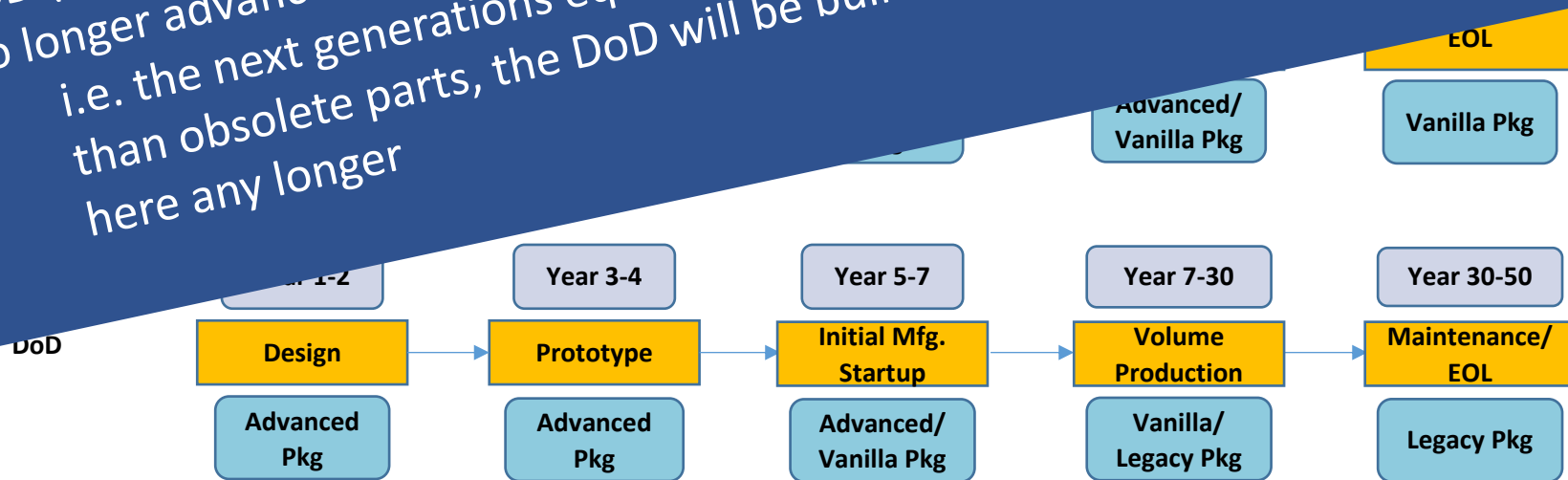
- **What is advanced today will be vanilla tomorrow**

- We should ask ourselves - What will the next generation of people look like?

- It is fact that the premium associated with what is advanced today will be built here?

- If we have not solved for vanilla packaging, the advanced packaging solution we solved for is no longer advanced so can't be built here profitably

Large fear that the next generation will look at us as the generation that spent several billion dollars solving for an advanced packaging problem that was not the majority of the issues facing DoD (or commercial) when it was solved for, and the advanced packaging solution we solved for is no longer advanced so can't be built here profitably i.e. the next generations equivalent to the obsolete parts problem we face today, but rather than obsolete parts, the DoD will be built on obsolete packaging technology we can't build here any longer



IP Challenge

- **DoD does not own their IP**

- Buying all commercial components with DoD volumes is not sustainable – they will go obsolete in many cases before a new system has fielded their first unit
 - Too much fear and lack of knowledge in the DIB on commercial best practices
 - Horror stories of spinning new silicon because of design issues...modern EDA tools/emulation avoids these issues
- Having FPGA devices without the software inside the FPGA leaves the DoD vulnerable
- Having entire systems and only the DiB knowing the components inside the system is a vulnerability

Funding Challenge

- **Lots of discussions in various industry meetings, conferences, etc. - CHIPS is not enough to re-shore this industry**
 - It took a couple of years of negotiations to get the current legislation passed (still negativity – corporate welfare)
 - National security concerns associated with not getting state-of-the-art and state-of-the-practice back onshore
 - China set on OSAT dominance (<https://anysilicon.com/osat-outsourced-semiconductor-assembly-and-test/>)
 - Because OSAT companies do most packaging, and they want control of the semiconductor market
 - United States today has only 3% of semiconductor packaging, assembly, and test onshore
 - DoD requires a multi-vendor solution across multiple generations of technology
 - Not enough money for the vendors requesting funding
 - The USG should focus on pure play environments as a priority
 - OSAT model can package/test for any device manufacturer out there

CHIPS+ Challenges



- If the DoD wants to achieve the vision, careful selection is required from the USG on CHIPS funding
 - Facilities that will only process DoD business will have to receive further USG funds because the volumes from DoD will not sustain the model, so the equipment will once again age and not be what the DoD needs in the future
 - Facilities that only want to focus on Commercial, like the offshore giants, may agree to do low volume high mix now so they can get funding, but how long before the DoD is kicked out of those companies as they were previously?
 - Companies in existence today that serve both commercial and DoD and have the “pure play” model are the safest bet for the DoD to attain the vision

Some Recommendations

How to Achieve Objectives - DMS



A solution for DMS issues must be addressed:

- Recognize that some of the below are constrained by current USG policy
- DoD should establish the “front door” organization as an internal DoD organization and require all programs “procure” components from the “front door” organization (obsolete and current versions)
 - Note: the actual procurement/inventory should come from industry partners as it is challenging to have a DoD organize this transaction – the “front door” is there to centralize knowledge as well as shield end use by using industry partners that procure for multiple uses
- DMS buys should be handled by a company that specializes in ME and has commercial customers as well as DoD
 - When Integra (for example) buys parts, nobody knows what the end use is; it could be a fish finder, or it could be F35
 - Instructions/authorization to buy should only come from the DoD front door organization via a classified contract
 - Meaning the existence of the contract between the “front door” and the ME company should not be public and require the ME company to maintain confidentiality on all buys
 - Contract should be a multi-year contract vs. single buys, or we will burden the process too much
 - ME buys in the DMS space must be quick, or you risk losing the parts

How to Achieve Objectives - DMS



A solution for DMS issues must be addressed:

- Aligning the DMS process to the vision
 - Integra has done many DMS buys for various programs – one such buy was for the F35 program office
 - We were told the JPO had been quoted \$170M for a redesign because the parts were not available
 - Largest issue with JPO was the timeline for the redesign
 - Integra sourced the parts, did authenticity verification, and shipped to JPO for \$20M = \$150M savings to the USG
 - Integra estimates that if these parts had been sourced before they were obsolete, the same quantity of parts could have been sourced for \$250K
- The most affordable, secure, and timely means of solving DMS is to avoid DMS
 - “Front door” organization should gather program component usage and estimate EOL needs
 - Recognize with current IP issues, this will be a long and time-consuming process, but there are decades of DMS issues waiting on us if we don’t get started
 - ME organization should procure components before they become obsolete and store them in a SCIF for the USG to pull from
 - Realize that means buying a significant number of components up front and storing them, but one redesign for obsolescence eats up significantly more DoD resources (time and money) than the cost to establish an inventory program at a Trusted ME house
 - Again, avoiding bureaucracy should be key here with a 5yr IDIQ or similar contract and minimal paperwork for requests to buy and requests to pull inventory – failure to do so will add time and cost, thereby minimizing the success of the vision

How to Achieve Objectives - Packaging

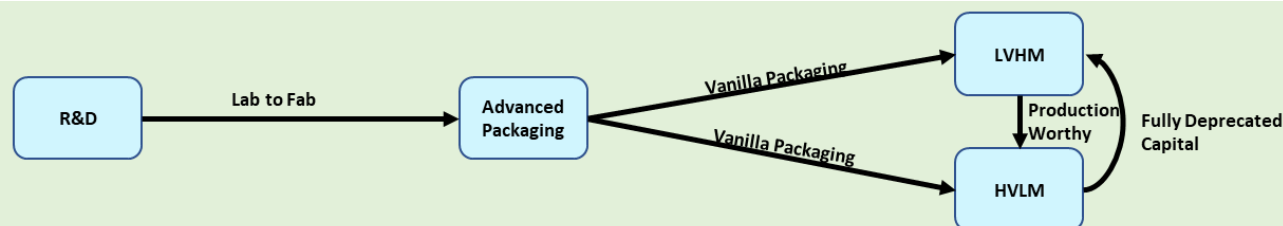


- **Advanced Packaging is critical for the future!**

- Looking at the DoD lifecycle proves that we must solve for vanilla today, or, when current SOA packaging technology moves to vanilla, we fail the “guaranteed” access portion

- **Vanilla Packaging is critical**

- “Long-term access” requires a sustainable model for vanilla packaging
 - This should be a priority in the next few years
- The only way to create a sustainable model is through volume packaging
 - Understanding that while labor is a serious use of cash, it is not the only use of cash
- Volume packaging for commercial customers results in sufficient revenue and requirement from commercial customers to keep capital constantly refreshed – resulting in DoD having a constant supply of SOA equipment available



How to Achieve Objectives - IP



- **As long as the DoD does not own their IP, they will be at the mercy of the DiB, and you will have recurring instances like the F35 example where the redesign can't happen fast enough (timely access), and the cost will be many times (affordable) what it has to be**
 - A strategy must be developed to own the IP
- **How do you encourage the DiB to use the most capable ME?**
 - Require digital engineering on new designs
 - Perhaps not realistic on components like resistors and capacitors – for these, we should inventory lifetime supplies
 - Require DoD own the IP that results
 - Require digital engineering solutions to DMS issues
 - For example, depending on expensive FPGA chips and software for long-term success is not sustainable
 - DiB approach when DMS happens is to design in the latest FPGA version – again and again
 - You could employ the inventory solution for the FPGA, but digital engineering would allow for complete system emulation and optimization before fielding a system and DoD owning the IP
 - Future capability upgrades become less expensive with digital design and emulation
 - Prototype, debug, optimize and refine from your desk instead of the manufacturing floor

How to Achieve Objectives - IP



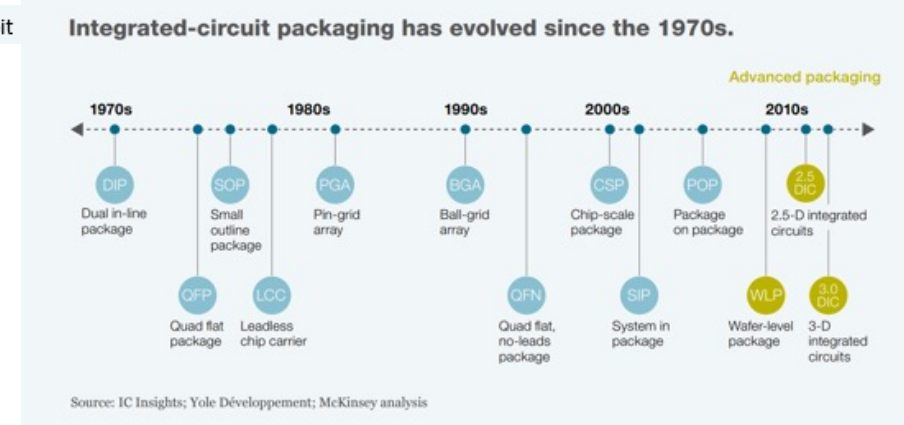
- Companies using a pure-play model with a proven track record on both commercial and low volume high mix (DoD) work is the quickest way to “ensure” a stable supply & own the IP
- A partnership with a lab like Army (for example) and industry would be ideal and potentially the quickest implementation
- DoD should take more advantage of SOTA tools to support sustainment of critical weapon systems
- Partner with a company that believes the DoD should own the IP and not the ME company
- Partner with a company that will build the resulting design for decades instead of a handful of years
- Sustainability is critical here – owning the IP with a partner that does not have a sustainable model would be a failure

Advanced Packaging Sustainability



- What is Advanced Packaging (state-of-the-art) today will be Vanilla (state-of-the-practice) tomorrow
- Notice the time horizon to the next packaging technology is shrinking
- Those who have been in the industry know that each evolution has been considered “advanced” at the time

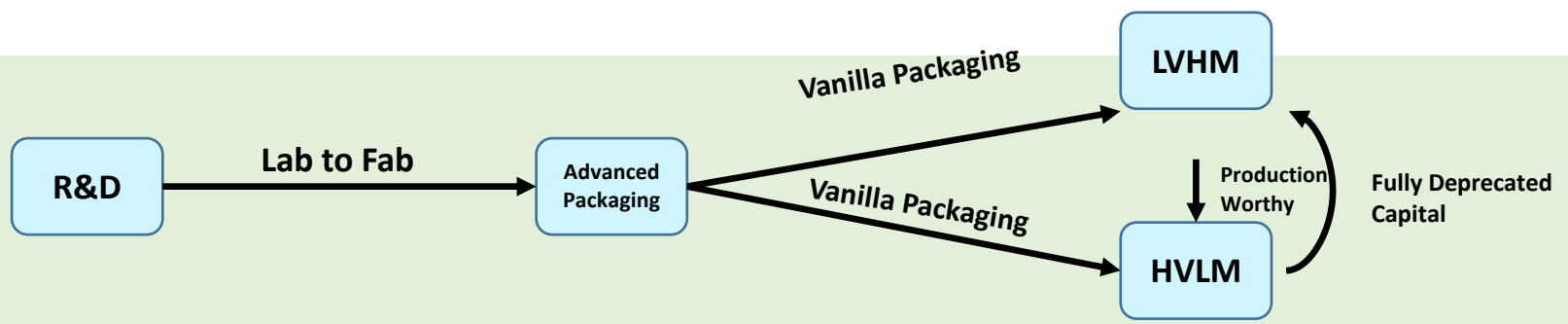
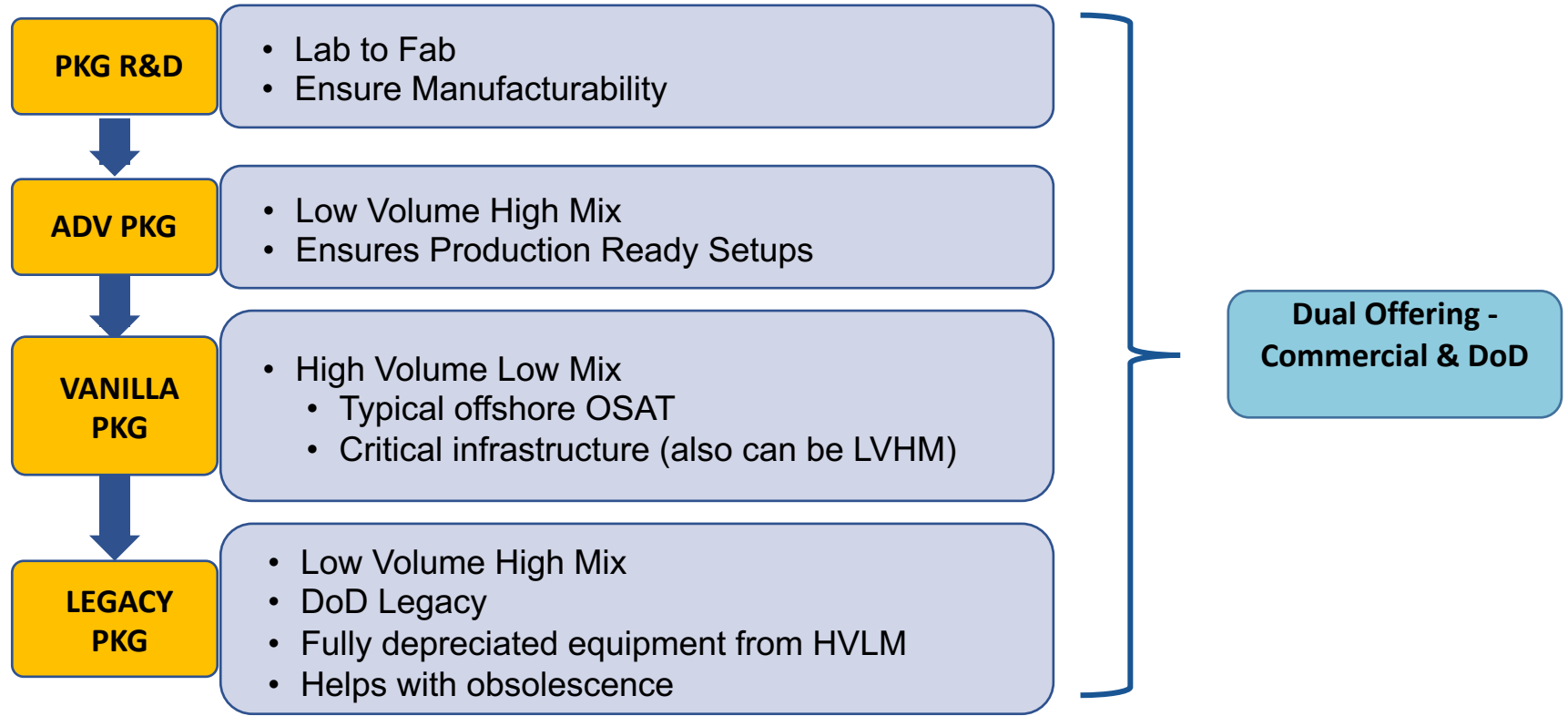
Exhibit



- Advanced Packaging looks attractive in the U.S. now because there is a premium associated with SOTA but when that SOTA becomes SOTP and the premium goes away you need to be able to competitively and profitably produce what will be vanilla packages
- Practical reality is customer demand is still primarily 1990s technology (QFN, BGA, Flip Chip) and even some QFP technology in the automotive sector - with the right model these lend themselves to being built profitably onshore

Using the traditional model employed in the packaging world today, when it is no longer advanced, it will no longer demand a premium, and will not be manufacturable in the United States – we must change the traditional model if we want to avoid watching what is state-of-the-art today move offshore as new technology emerges

Sustainable Business Model Achievable - Dual Use Facility



- **Heterogeneous Integration poses many problems to solve; some of the key ones are:**
 - Design for Test – How to mitigate increased tester resources due to multiple Chiplets or do we? Does KGD allow system level focus?
 - Understanding signal integrity for multiple technology Chiplets upfront and then DFT
 - How to do some level of robust functional testing or do? Or Is continuity or contact resistance test enough? The industry has successfully used this approach at PCB to component level attach. Can this be adopted for multiple Chiplets on a package?
 - Microprocessors have multiple functional blocks and we use loop back testing. Can such test be developed for heterogeneous packages
 - Test for yield at completed HI package level may be costly – Can yield be determined on a step by step basis as we assemble the package?

Heterogeneous Integration – Test Challenges



- Design and development of software and hardware across all technologies
- KGD/singulated die testing
- Test characterization at individual chiplet level
- Help in modeling the test protocols for HI package where the final product has
 - Die to die integration
 - Die to package integration
 - Package to package integration
- Help in developing appropriate test protocols

A Simplistic Model to Consider for CHIPS Funding to Work For OSATs



- **Barriers to U.S. OSAT**
 - Capital costs coupled with high labor costs
- **CHIPS funding eliminates barrier - upfront capital costs**
- **Make funding create financially sustainable business – Do not count on continued government funding**
 - Business plan with ROI from CHIPS
 - A combination of R&D, LVHM and HVLM to maximize ROI on capital
 - HVLM can be used to sustain the capital needs of the LVHM market
 - R&D and LVHM can be used to guarantee the HVLM production worthy setups

LVHM: Low Volume High Mix – Defense and Aerospace

HVLM: High Volume Low Mix– Typically automotive or commercial products

“You know, overall, the indications are exactly as you say. The package assembly test, which is generally more dependent on low labor cost, has even drifted more aggressively to Asia.”

Pat Gelsinger CEO Intel - March 23, 2022 – Senate Commerce, Science & Transportation Committee Hearing



THANK YOU

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