

Fan-Out: Will it continue to exceed expectations?¹

OUTLINES:

- Fan-out platform is increasingly viewed as one of the top packaging options.
- Fan-out is a stable-growing market with revenue growth of 19% from US\$1,584 million in 2019 to US\$3,864 million in 2024.
- Total equipment & materials revenue is forecasted to surge more than US\$700 million in 2024, with a good growth as well: Yole announces a 20% CAGR between 2018 and 2024.
- TSMC'S new fan-out capabilities are exciting. InFO capacity expansion is expected.
- Competition in core fan-out is tougher than before with PTI² coming in strong.

*“We have seen a growth in adoption of FO³ packaging over the year.” Indeed **Stéphane Elisabeth, Technology & Cost Analyst from System Plus Consulting** tells us the story: “It started a long time ago... Samsung has lost Apple’s APE packaging fight to TSMC thrice in a row since 2016. But, with SEMCO FO packaged APE+PMIC by panel-level manufacturing, the competitive landscape has been modified. Then, today, with PTI a potential leader in FO, an exciting new chapter in fan-out history begins.”*

Under this dynamic industry, System Plus Consulting offers a comprehensive reverse engineering and cost analysis dedicated to the FO packaging: [Fan-Out Packaging Processes Comparison 2020](#). The company proposes an overview of the FO technologies available on the market developed by leading packaging companies: Infineon’s eWLB - nepes’ RCP - TSMC’s info - Samsung’s ePLP - ASE’s M-Series. Analysts also detail a comparative study of eight selected components from PMICs⁴ to processors including radar MMICs⁵ using FO technologies. This report highlights the technical choices made by leading OEMs⁶ and reveals

¹ Extracted from :

- [Fan-Out Packaging Processes Comparison 2020](#) report, System Plus Consulting
- [Equipment and Materials for Fan-Out Packaging](#) report, 2019, Yole Développement
- [Fan-Out Packaging: Technologies and Market Trends](#) report, 2019, Yole Développement

² PTI : Powertech Technology Inc.

³ FO : Fan-Out

⁴ PMIC: Power Management Integrated Circuit

⁵ MMIC: Monolithic Microwave Integrated Circuit

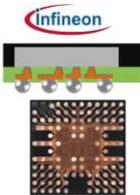
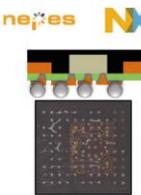
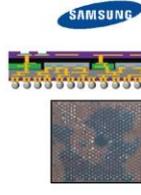
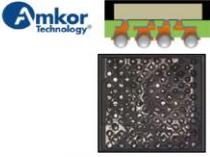
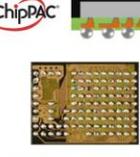
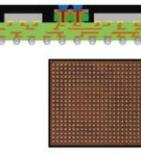
⁶ OEM: Original Equipment Manufacturer

a detailed cost analysis of each solution. Detailed information about System Plus Consulting's FO report is now available: [Here](#).

Without doubts, TSMC is the HD FO fan-out leader. SEMCO, Samsung's subsidiary is probably the next biggest FO contender. And today PTI appears as a potential OSAT⁷ outsider in FO... Because of innovations and market evolution, the battle will never end. System Plus Consulting and its partner [Yole Développement \(Yole\)](#), tell you the story.

Fan-out packaging platform selected by leading semiconductor companies & key features

(Source: Fan-Out Process Comparison report, System Plus Consulting, 2020)

 <p>Infineon RXN77XX:</p> <ul style="list-style-type: none"> o Process: Infineon's eWLB o Features: Back Side protection o Substrate: 200mm Wafer 	 <p>NXP MR2001XXX:</p> <ul style="list-style-type: none"> o Process: Nepes's RCP o Features: Lead Frame o Substrate: 300mm Wafer 	 <p>Apple A12:</p> <ul style="list-style-type: none"> o Process: TSMC's inFO o Features: Copper Pillar o Substrate: 300mm Wafer 	 <p>Samsung Exynos 9110:</p> <ul style="list-style-type: none"> o Process: SEMCO's ePLP o Features: Back Side RDL, Via Frame o Substrate: 20x16" Panel
 <p>Qualcomm WCD9335:</p> <ul style="list-style-type: none"> o Process: Amkor's eWLB o Features: - o Substrate: 300mm Wafer 	 <p>Qualcomm PM8150:</p> <ul style="list-style-type: none"> o Process: ASE's M-Series o Features: - o Substrate: 300mm Wafer 	 <p>Cypress CY8C68237FM-BLE:</p> <ul style="list-style-type: none"> o Process: STATSChipPAC's eWLB o Features: - o Substrate: 300mm Wafer 	 <p>NXP SCM-IMX6:</p> <ul style="list-style-type: none"> o Process: nepes's RCP o Features: Via Frame o Substrate: 300mm Wafer


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TSMC has further extended its lead in the HD FO⁸ market, with gen-2 inFO HVM⁹ production and successful qualification of gen-3 inFO for Apple's iPhone APE¹⁰. "TSMC understands that industry technologies and applications are undergoing unprecedented change in a new, digital megatrend driven era", explains **Favier Shoo, Technology & Market Analyst at Yole**. "Consequently, exciting technological developments exist to address these new demands."

TSMC has commenced risk-production of inFO-oS¹¹ for HPC¹² qualifications. Moreover, the company is developing inFO-AiP¹³ for mmWave applications (5G, etc.), and inFO-MS¹⁴ for

⁷ OSAT: Outsourced Semiconductor Assembly and Test

⁸ HD FO : High- Density Fan-Out

⁹ HVM : High-Volume Manufacturing

¹⁰ APE : Application Processor Engine

¹¹ oS: on Substrate

¹² HPC : High Performance Computing

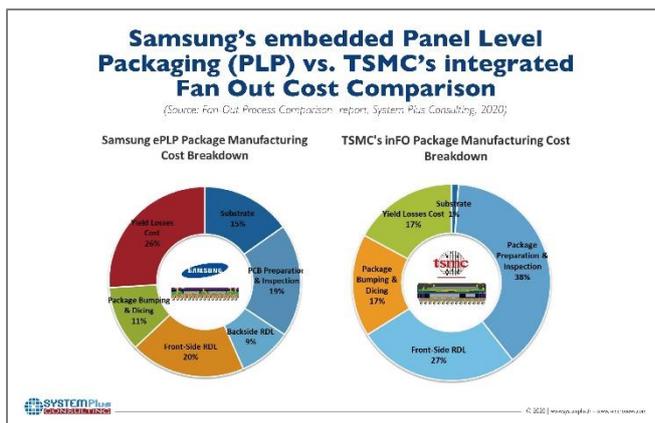
¹³ AiP : Antenna-in-Package

¹⁴ MS : Memory-on-Substrate

data-server applications (i.e. cloud). TSMC is also creating a new market segment called UDH FO¹⁵, with a very aggressive sub-micron L/S roadmap and >1500 I/O.

In the “core” FO market, SEMCO and PTI have stolen the limelight by rolling out FOPLP¹⁶ volume production for the first time in FO packaging history. SEMCO utilized ePLP¹⁷ technology in the Samsung Galaxy smartwatch for the consumer market, for a multi-die FO package consisting of APE + PMIC with ~500 I/O. PTI successfully commenced FOPLP PMIC in LVM¹⁸ for MediaTek’s automotive radar application.

For packaging houses to remain attractive for key fabless players like Qualcomm and MediaTek, cost-reduction is necessary. To this end, SEMCO, PTI, ASE/Deca, and Nepes have invested in FO at panel-level by leveraging existing facilities and capabilities to achieve economy-of-scale production. Currently, SEMCO and PTI have been able to kick-start production. It is also understood that for panel to be profitable and achieve real cost reduction, the yield for panel-level processing requires optimization. Hence more optimization and qualification of FOPLP technology is expected.



Physical analysis led by System Plus Consulting points out all FO applications. For each of them, analysts investigate the technical and strategic choices made by OEMs and their packaging partners. Thermo-mechanical performance, high I/O, SiP, side wall protection... The reverse engineering & costing company details the manufacturing processes:

- As an example, Denso’s 77 GHz radar features two receivers, one transmitter and one power amplifier MMIC. Transmitter’s function is to send data through the power amplifier and also send the local oscillator signal to the receivers. *“This structure is typical to Infineon as the VCO is only on the transmitter MMIC”*, comments Stéphane Elisabeth from System Plus Consulting. *“These three type of MMICs are all packaged using eWLB technology.”*
- Another example could be the comparison between Infineon Technologies’ eWLB vs. nepes/NXP’ RCP for thermo-mechanical performance, both dedicated to the automotive market. Both MMIC are package with the same form factor. The only difference is the thickness of the packaging. According to System Plus Consulting’s analysis, in the RCP package, the copper RDL cover almost 80 % of the package size whereas in the eWLP is less than 10%...

¹⁵ UDH FO : Ultra-High-Density Fan- Out
¹⁶ FOPLP : Fan-Out panel-level packaging
¹⁷ ePLP : embedded Package-Level-Packaging
¹⁸ LVM : Low Volume Manufacturing

Of course, the story will not stop here. Latest financial announcements made by TSMC on Jan. 16¹⁹ point out the strategy of the leading company to accelerate its developments and increase its presence towards the advanced packaging industry. Figures announced are impressive and will strongly impact the overall supply chain.

All year long, System Plus Consulting and Yole will pursue their investigation to follow the game. Both partners will analyze announcements and debate with leading players to collect key market and technology trends to provide valuable analyses. Stay tuned on i-Micronews.com to follow our activities including webcasts, articles, interviews, reports and more!



The Battlefields of Fan-Out Packaging – Webcast powered by Yole Développement and System Plus Consulting is still available. Watch the recorded version and send us your questions on i-Micronews.com.

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¹⁹ Source : TSMC financial report, Jan. 2020

About our analysts

Dr. Stéphane Elisabeth has joined System Plus Consulting's team last year. He has a deep knowledge of Materials characterizations and Electronics systems. He holds an Engineering Degree in Electronics and Numerical Technology, and a PhD in Materials for Microelectronics.

Favier Shoo is a Technology and Market Analyst in the Semiconductor & Software division at Yole Développement, part of Yole Group of Companies. Based in Singapore, Favier is engaged in the development of technology & market reports as well as the production of custom consulting reports.

During 7 years at Applied Materials as a Customer-Application-Technologist in the advanced packaging marketplace, Favier developed a deep understanding of the supply chain and core business values. As an acknowledged expert in this field, Favier has provided training and held numerous technical review sessions with industry players. In addition, he has obtained 2 patents.

Prior to that, Favier worked at REC Solar as a Manufacturing Engineer to maximize production capacity.

Favier holds a Bachelor in Materials Engineering (Hons) and a Minor in Entrepreneurship from Nanyang Technological University (NTU) (Singapore). Favier was also the co-founder of a startup company where he formulated business goals, revenue models and marketing plans.

About the reports

Fan-Out Packaging Processes Comparison 2020

In-depth technical and cost overview of key Fan-Out process technologies from Infineon, nepes, TSMC, SEMCO and ASE.

– Performed by System Plus Consulting

Equipment and Materials for Fan-Out Packaging

Electronic packaging equipment and materials revenue growth is highly reliant on big players' investments. A new killer application is needed to fuel robust growth. – Performed by Yole Développement

Fan-Out Packaging: Technologies and Market Trends 2019

Samsung and PTI, with panel-level packaging, have entered the Fan-Out battlefield. - – Performed by Yole Développement

About System Plus Consulting

System Plus Consulting specializes in the cost analysis of electronics, from semiconductor devices to electronic systems. Created more than 20 years ago, System Plus Consulting has developed a complete range of services, costing tools and reports to deliver in-depth production cost studies and estimate the objective selling price of a product... [More](#)

About Yole Développement

Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide... [More](#)

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