CROSSROADS CAPITAL LLC

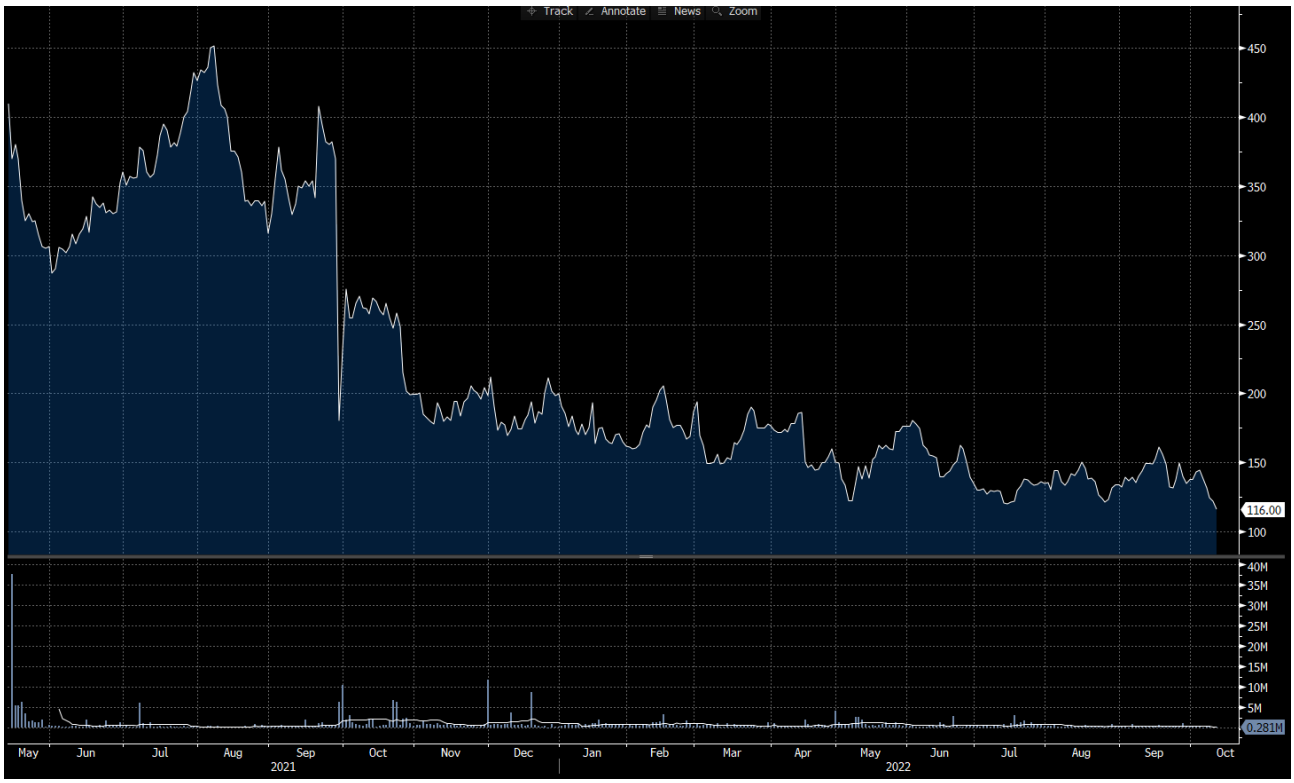
5440 West 110th Street, Suite #300
Overland Park, KS 66211,
+1 (816) 610-2437 | contact@crossroadscap.io

Alphawave IP (AWE – London)

Special Report | October 12, 2022

Alphawave IP (AWE – London)

Niche Semiconductor IP Firm Leveraging Leadership to Create Scaled Marvell-Like Business



Source: Bloomberg.

Price	£	1.16
Shares Outstanding (M)		713.75
Market Cap	£	827.95
Net Debt	-£	335.61
EV	£	492.34
Daily Trading Volume		250K-500K

1) Thesis Description

Alphawave IP (AWE) is a semiconductor firm focused on developing high-speed wired connectivity IP for data infrastructure end markets. The complexity at the leading edge of semiconductor design is necessitating a new tool kit for wired connections inside and between chips as traditional methods of scaling down wiring no longer yield competitive results. The company's founders have extensive knowledge of this niche domain (SerDes) and have quickly developed a unique connectivity IP portfolio, already a year or so ahead of competitors, which has allowed them to rapidly gain share in a short period of time. While the company IPO'd in May of '21 and have incurred erroneous accusations of illegitimacy/self-dealing in the press, the adoption of their solutions is expected to truly

materialize in ’23 as design wins from ’19-’21 scale up into full production. With their lead in connectivity IP accelerating, Alphawave is now undergoing a transformation to provide entire connectivity chiplet design solutions in addition to licensing following the acquisition of OpenFive, a SoC design firm. This transaction should create a scaled firm in the style of Marvell as the adoption of chiplets massively increase the number of connection points within data centers/networks and therefore AWE’s market.

The thesis is as follows:

1) At the current price of ~£116p/share, the market assumes no revenue growth beyond their ’23 guidance of $325M-$360M and 40%-45% margin outlook on a ~4.5x EV/EBITDA valuation multiple. Valuation ranges from £175p/share to £2,300p/share over five years, with scenarios ranging from no growth/no Chinese revenue to ~$3.5B in revenue (half of MRVL) at a FCF valuation on par with Marvell (~25x).

2) An opportunity is available due to several reasons:

    a. **Alphawave’s ’17 founding, Chinese exposure and overall success coupled with a mid-’21 IPO, still draws significant investor skepticism as to the validity of the enterprise.** Alphawave was founded in ’17 by three engineers with decades of experience starting up and monetizing semiconductor IP companies, selling their last SerDes (serial-deserialization) IP firm, V Semi, to Intel in ’12. Deep experience in a niche, and growing segment of the IP market coupled with clever strategies to onboard two large Chinese customers (more on that below) has resulted in revenue over $100M from ~28 customers in just a few years. This pace of growth and market presence is almost unheard of in the semi IP market and with its IPO conducted so early in the life of the company, the event was generally perceived as an exit for the founders before their technology phased out. However, since then, Alphawave now boasts Microchip, Broadcom, Google, Microsoft, and Intel as customers. Further, foundries TSMC, Samsung and Intel have approved AWE as a top-tier vendor. Given the recency of these new wins and the roughly two-year design cycle for new Application-Specific Integrated Circuits (ASICs), customer volumes/royalty revenue have yet to show up to Alphawave in scale as most of the revenue base currently consists of license sales and non-recurring engineering fees. Material growth in royalty revenue is expected from almost all AWE’s customers as their solutions are well ahead of competitors and customer physical chip production/delivery is highly probable. Further, discussions with industry participants indicate that leadership at AWE is legitimate, highly thought of and their unique technical/business strategies put them in a league of the largest IP players in the industry (SNPS, CDNS, ARM). Given the market’s appetite for recent IPO’s, significant (current) Chinese exposure and the lack of operating history, AWE trades at a ~4.5x EV/EBITDA (~4.75x EV/FCF), while top tier firms are typically valued at 10x-20x (ex. covid timeframe).

    b. **Late September ’21 ‘hit piece’ exaggerated the materiality of founder-related transactions and implied nefarious intent, when in actuality everything was above-board and fully disclosed.** At the time of the IPO, Alphawave’s two big subscription license sales were to Chinese firms, VeriSilicon and WiseWave. Disclosed in the prospectus was WiseWave’s ~7% ownership of AWE and their joint

venture in China. While not directly related to the founders, the VeriSilicon CEO is the brother-in-law of Dr. Sehat Sutardja, the co-founder of Marvell who is also a ~13% owner of AWE. From discussions with industry participants, this was an above-board transaction as the commercial relationship with VeriSilicon preceded any investment from Dr. Sutardja and while not disclosed in the prospectus since the relationship was one degree removed, management nonetheless discussed it with investors. Further, Alphawave's Chairman John Holt, was a co-founder and director of Achronix, an AWE customer amounting to ~$6M in '19 and only ~$1.8M in '20 on a ~$30M revenue base. Achronix should amount to only ~$1M of revenue in '22. Importantly, Mr. Holt resigned from Achronix in July of '21. Despite these nuances, an article written in late September '21 highlighted these points as if they were obscured from the public, all the while failing to note the appropriate disclosures in the prospectus and the fact that management communicated to investors about these relationships with total transparency at the time of the IPO. Following publication of the article, AWE dropped ~50% and has yet to recover despite management clearly discussing the nuances for the last year. Subsequently, a material subset of financial participants continue to believe this company is illegitimate or has less than reputable management. From their filings, related party transactions outside the WiseWave JV (more on that below), now amount to ~2% of revenue versus the ~20% at the time of IPO. This legacy concern is likely one of the top two biggest reasons for a mispricing of AWE, despite the robust growth in blue-chip semi customers utilizing the company's technology and management's forthrightness.

c. **Fears of Chinese customer and investor overexposure should diminish rapidly given WiseWave's exit and strong growth outside of the region**. Entering the Chinese market aided AWE in scaling up quickly, given the appetite of the country's semiconductor industry for access to leading edge technology. VeriSilicon and WiseWave subscription deals amounted to a potential ~$255M in revenue over several years (including a possible ~$105M extension from WiseWave) and yet trailing 12-month AWE revenue ex-China equated at the time of IPO to ~$35M. WiseWave's subscription deal was structured as a JV, with the PE Firm (Wise Road Capital) taking ~7% ownership in AWE (along with dual capital commitments). Chinese-derived revenue equated to ~60% of total at YE'21 and has since declined to 35%-40% in 1H/22. However, with the acquisition of OpenFive (US company with majority of sales in NAM), post-CFIUS approval resulted in both Alphawave and WiseWave agreeing to reduce its ownership and keep its commercial relationship steady. As such, the company no longer expects WiseWave to exercise its license extension in '23 (already embedded in guidance) and cease its JV capital commitments. The PE firm has already exited 1/3 of its position in AWE with ownership now at ~4%. We anticipate WiseWave exits entirely by the end of next year, representing a possible re-rating as the stigma of their ownership goes away. Additionally, given the slower pace of revenue growth in China (possibly flattish) and over ~55% annual growth for AWE ex-China and OpenFive's ~80% NAM exposure, we expect NAM revenue to increase to 60%-70% of revenue and Chinese related revenue to decline to 20%-25% in '23 and 10%-15% in '24. Far below their previous expectation of ~30% long term. The current regional overexposure and escalating

tensions between the West are likely the biggest reason for Alphawave's mispricing and the trajectory of the business suggests this operational risk should be substantially lower in the future more quickly than most anticipate. Importantly, any effective restrictions on leading edge semis going into or being made in China by the US/West would simply accelerate the reduction in materiality of Chinese revenue on AWE as opposed to creating a going concern risk that many believe would occur.

d. **Acquisition of OpenFive underestimated by investors as it allows Alphawave to move up into the larger chip design market by providing complete chiplet designs as opposed to just IP products.** In AWE's prospectus, the stated reason for the IPO was to have access to capital to accelerate their market ambitions providing higher-value connectivity solutions predominantly at the chiplet level. OpenFive was the '20 creation of Open Silicon and SiFive (a RISC-V IP firm), a scaled firm of ~300 engineers providing domain-specific chip designs for RISC-V and ARM architectures. Alphawave worked with SiFive to carve out the design business as it became a stranded asset within SiFive as they focus solely on RISC-V CPUs, purchasing it for ~$210M (10x-12x EV/EBITDA) in early '22. With greater chip complexity, a wider variety of architecture libraries and a more diverse customer base focused more on technical differentiation rather than technical development, outsourced custom design solutions are expanding rapidly in the marketplace. The transaction almost triples AWE's customer base to ~80 representing a large cross-sell opportunity, doubles IP products to ~155 encompassing a wider range of connectivity products and expands the company's competitive advantage as they can solidify their first-to-market IP position into fully designed chips. More importantly, the combination massively expands the company's revenue opportunity set as IP products typically garner $2M-$5M per license plus royalties, while designed chiplet solutions generate $30M-$50M per design (plus royalties and larger support fees) with easier sales cycles given that customers can simply approve a complete chip component based on their specs versus integrate an AWE IP product into their or another third-parties design. Further, design work is closely tied to a customer's less cyclical R&D spending, which affords Alphawave greater visibility, more durable earnings, and in turn, less terminal value risk at maturity. With the data infrastructure end markets having more complex requirements and massive customers, a custom silicon design division was critical for Alphawave scaling up the business to grow beyond its IP and more effectively compete with Marvell and Broadcom.

e. **Skepticism towards rapid growth over the next 3-5 years fails to account for the accelerating adoption in the data center of 112G SerDes and chiplets, several single technology/function chips connected together versus System on a Chip (SoC).** Alphawave's technology is predominantly focused on the leading-edge nodes for high-speed data transfer across wires in and between chips for use in data centers (transfer and storage), 5G telecom infrastructure and AI. The company's latest technology is at the 112G node, at least a year ahead of competitors, which is now at the base of the s-curve of adoption in the data center, an industry with a market of hundreds of millions of connection points necessitating high-speed transfer. However, an underestimated growth vector, and just as impactful is the industry transition to chiplet designs. Manufacturing

yield/complexity issues with SoCs at the leading edge have driven semi fabs/designers to split the functions of a system on a chip into smaller parts allowing them to have various technology nodes connected into a single equally capable product with less cost. Translating this to Alphawave, instead of one SoC with one connection point and therefore one license/royalty unit, a chiplet doing the same job combining 5-10 different components increases the amount of connection IP licenses required. In essence, transition to chiplets has the potential to expand the connection points within several data infrastructure verticals, and AWE license/royalty revenue, by 5x over time (even more if chiplet components are interconnected). While early in this transition, adoption of chiplet designs is expected to grow exponentially over the next few years now that industry participants have agreed on a standard for chiplet connections, Universal Chiplet Interconnect Express (UCIe), derisking both the market for chiplets and Alphawave's technology solutions utilizing said standard.

f. **UK listing allows for flexibility but obscures the company's North American roots/operating style, and limits interest from US technology investors/Sell-side firms.** Alphawave IPO'd on the London exchange for several reasons. The UK domicile allows greater flexibility to sell into the US and Asia with lower risk of restrictions. Second, the greatest supply of SerDes specific engineers is in London and the company's headquarters in Ontario, Canada. Third, was to entice local investors by drawing analogies to ARM. An analogy which has since changed as AWE acquired OpenFive, but necessary given the differing market focus (data infrastructure vs. ARM's mobile markets) and evidence of ARMs struggles to gain profitable share in data centers as just an IP firm (a SoftBank induced initiative). However, the largest pool of technology capital is in the US, where knowledge of AWE is limited. A secondary effect of this UK domicile is minimal Sell-side coverage, currently at three analysts. Additionally, its UK domicile may be a source of mispricing given the volatility in the country recently and a cursory belief Alphawave is European run, a generally unappealing proposition to US investors. At its core, AWE is a Canadian company with financials in US dollars and soon, most of its revenue from US customers, that happens to be listed in the UK. As the company grows in size and mind share, particularly as they win more NAM customers, we would anticipate a possible NASDAQ listing in the coming years and at the very least greater investor outreach in the US.

g. **Significant founder and board ownership limit share liquidity and near-term investor interest.** The three founding engineers own ~40%, followed by Dr. Sehat Sutardja with ~13% and John Holt/WiseWave at 2%/4% each, totaling 55%-60% of shares outstanding. Adding to ownership concentration, despite the IPO lock up ending late '21, insiders only sold down their position minimally and Dr. Sutardja actually increased his position with shares in the £120p-£140p range. Interestingly, AWE comprises ~10% of the Sutardja family's net worth. While share liquidity for investors is somewhat limited (250K-500K shares daily), greater interest in the semiconductor sector or the company, an exit by WiseWave, and/or modest secondary sales by insiders, or a listing on the NASDAQ would increase the amount of shares available and actively traded.

3) The largest micro risks in the name are customer concentration, execution issues with the OpenFive acquisition, technology development issues and loss of design wins, and overall technological obsolescence. The largest macro risks are the levels of data center/hyperscaler spending, 5G infrastructure buildout, chiplet adoption, and China/West tensions/restrictions.

2) Business Analysis

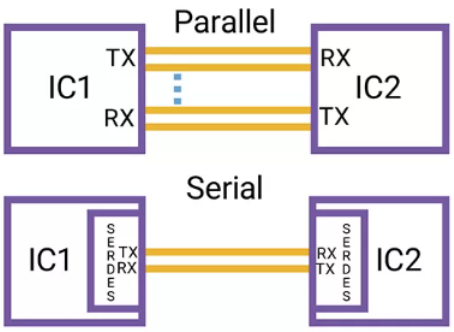
A Brief History: Founded by successful SerDes engineer-entrepreneurs, targeting paradigm shift in chip connectivity development/design

Alphawave was founded in '17 by Tony Pialis, (CEO), Raj Mahadevan (COO) and Jonathan Rogers (SVP Engineering). All three were previously at Intel from '12-'17 after their company V Semi was acquired. V Semi was a multi-standard SerDes IP development firm. Prior to V Semi in the early '00s, the team met at Snowbush Microelectronics, an analog IP licensing and design firm for high-speed connectivity.

All of these companies utilized analog-based analysis/methods for scaling down wiring to and from a chip utilizing SerDes (serial/deserialization). While not a comprehensive description, SerDes is a method of high-speed data transfer that is channeled through specially engineered transceivers at each chip connection point and is a necessity for any semiconductor.

Essentially, communication between two chips with multiple I/O connections can be done in parallel, sending data through ports at the same time to the receiving chip/chips. However, if one has 5 I/O ports on a chip, sending data out simultaneously consumes a lot of power, can have electromagnetic interference, and reduces functionality if limited on the number of ports in a chip, all resulting in a bigger/more complex chip.

SerDes takes all the data on the chip that is to be transferred, packages it up (serializes) in the transceiver, sends the data through one I/O port, which is then broken back down (deserialized) in the receiving chip. This results in lower power consumption and EM interference, fewer I/O ports required to send an equivalent amount of data and ultimately a smaller, less complex chip. Using parallel transmission would also relegate other chip components to be clocked at the same frequency, a design constraint that severely limits a chip's performance/flexibility.



Source: Synopsys.

SerDes was created in '90s and since then data rate throughput has increased exponentially. But as chips scaled down from 28nm transistors to 7nm, traditional methods of essentially just shrinking the wiring started to show issues generating sufficient data transfer levels with acceptable EM interference and wire resistance/capacitance. In chip design, the physical wires between them became the bottleneck to faster speeds and lower power consumption.

This is forcing an analog engineering domain (PHY, the Physical Layer) into a mixed-signal world as digital solutions are required to meet the analog challenges at the leading edge. As such, SerDes designers utilizing digital signal processing (DSP) to manage these problems is a niche within a niche. In fact, below 7nm analog SerDes methods break down substantially. Notably, Alphawave was the first IP vendor to demonstrate functional silicon SerDes solutions at 7nm in '18. Leading edge designs are now at 3nm.

During their time at Intel, the founders would have had visibility into this scaling problem as the company was the leader in high performance server applications in the early '10s. However, digital processing technology for a niche like SerDes was likely too nascent for a company like Intel to dedicate resources toward.

This is where Alphawave has developed unique IP by building their products off a DSP 'chassis'. Said another way, the company designed a single, configurable digital signal processor joined to an analog SerDes wiring solution. This results in a single product that can be configured for many customers' requirements on speed (up to 112Gbps), network protocol, number of pins, power consumption, reach size and API libraries.

Alphawave has DSP IPs, Integrated Product IPs, Chiplet IPs, and OpenFive services/IP in total 155 IP products and comprehensive chip design solutions with over 80 customers (~28 from Alphawave as of 1H/22). Approximately 70% of revenue is derived from product IPs.

DSP Connectivity IP Cores: The DSP IPs in AWE's portfolio cover speeds between 1Gbps up to 112 Gbps across multiple reaches, and network protocols. The next node under development is 224G, which would likely contain wired as well as silicon photonic solutions. Products are the ZeusCORE, AlphaCORE, ApolloCORE DieCORE100 and AthenaCORE.

Integrated Product IP Cores: Integrated IPs are semi-customizable full product solutions for repeaters in the connectivity channel (electrical and optical). Examples include the OctalCORE800 and HexaCORE1600 ethernet products. These ethernet (wired and optical) IP products acquired from AWE's purchase of Precise ITC in late '21.

Chiplet IP Cores: Chiplet IPs build off the DSP IPs with a combination of designs utilizing die-to-die interfaces and varying DSP SerDes Cores. Names for these products are the ZeusCHIP, AlphaCHIP and ApolloCHIP. AWE sold its first chiplet IP in late '21.

OpenFive: Open Silicon (founded almost 20 years ago) was purchased by SiFive, a RISC-V CPU design/IP firm in '20 and turned into OpenFive. SiFive is venture backed by Intel, AMD, Samsung, Coatue Partners and others, recently raising $175M at a $2.5B valuation. In a lead up to a potential IPO, SiFive realized that a design house was detracting

from full-on development of RISC-V CPU IP and unlikely to help in accelerating the RISC-V ecosystem. As such, SiFive adopted a pure IP model since they directly compete with ARM and sold OpenFive to Alphawave for ~$210M (10x-12x EV/EBITDA) in early '22. Top line growth of OpenFive over the last few years is unknown, however, two years ago the company had ~250 employees increasing to ~300 in '22, equating to ~10% per annum while likely being under-resourced.

OpenFive develops domain-specific custom System-on-a-Chip (SoCs) and chiplets across every stage of design, architecture, logic, physical, system, software, and IP. The company partners with fabs (TSMC Design Center Alliance member) to deliver fully tested chips. Both OpenFive and AWE joined Intel's Accelerator program in '22. Customer base is more than 50 entities and to date has completed over 350 tapeouts in addition to over 150 million chips delivered.

Going forward, Alphawave plans to redirect their SoC design expertise and develop chiplet designs/IP. OpenFive's portfolio is highly complementary to AWE, with memory and chiplet interface IP and a license agreement with SiFive for RISC-V IP.

Alphawave's revenue is based on a technology licensing model of licensing fees, non-recurring engineering fees (NRE), support and maintenance, and royalties.

Pro forma OpenFive, over 55% of revenue is from NAM, 20%-25% from China, 15%-20% APAC and ~10% from EMEA. Pro forma, AWE licensing should comprise ~55% of revenue, OpenFive ~40% and support ~5%.

Management History: Significant co-founder ownership (~40%); impressive management, shareholders

Tony Pialis, (CEO), Raj Mahadevan (COO) and Jonathan Rogers (SVP Engineering) are the founders of Alphawave. All three were previously at Intel from '12-'17 after their company V Semi was acquired. Prior to V Semi in the early '00s, the team met at Snowbush Microelectronics, an analog IP licensing and design firm for high-speed connectivity. At Intel, the team recognized the potential for digital signal processing for SerDes and once their pay packages vested, promptly left the company to start AWE. Tony and his team are widely regarded as great engineers in the industry for SerDes/high-speed signaling.

Dr. Sehat Sutardja joined the Board of AWE in '19 and at the time of the IPO had ~12% ownership in the business. In mid-'22, he increased his position with shares in the £120p-£140p range. Interestingly, Alphawave comprises ~10% of the Sutardja family's net worth. The Sutardja family has several investments across the semiconductor industry, but their ownership of AWE appears to be an outsized bet. The VeriSilicon relationship was already established before the Sutardja's were involved but in either case the company now should only generate ~$3M to AWE this year.

John Holt, the Board Chairman, owned ~4% of AWE at the time of the IPO and has since lowered his position to ~2%. Mr. Holt is the founder and former director of Achronix Semiconductor (stepped down in July '21). Achronix was an early user of Alphawave IP, but since '19 revenue generated by this counterparty has dropped to ~$1M per annum.

WiseWave at the time of IPO owned ~7% of AWE with a JV known as the CPP (Chinese Product Partnership). With the acquisition of OpenFive, both AWE and WiseWave agreed to limit new business and WiseWave has already started rationalizing their position in the company now at ~4%.

Directors and key personnel are expected to be compensated $3M-$4M this year with no incremental equity shares.

The executive team and insiders own 55%-60% of AWE.

Customer Dynamics: High-speed demands, chip complexity and speed to market driving customers to in-house design for custom solutions, while outsourcing specialized and 'difficult' IP/design like SerDes

Alphawave's customers end markets are predominantly data centers and networks (75%-80%), 5G infrastructure (~10%), solid-stage storage (~5%), and AI (~5%). The company in total has ~80 customers, including most of the top semiconductor firms and hyperscalers. Approximately 50% of revenue is derived from the top 3 customers for AWE, which is expected to decline with the integration of OpenFive, which has a much wider customer base. With only a few hundred potential customers, a large sales force is not required.

AWE's solutions are at the high-end of the market, targeting the most demanding compute/data transfer use cases, whose customers are focused on improving Power, Performance and Area (PPA) parameters of their silicon. With the slowing of Moore's Law on PPA improvements, these customers are redirecting their efforts into other aspects of chip design/manufacturing, opening up a wider variety of solutions from third parties.

Rapid data growth and customer demand for faster speeds, in and outside of the data center, is pushing the global data infrastructure industry to more widely adopt leading edge solutions more quickly to keep pace. This dynamic plus the success of open-source chip architecture RISC-V, has led to a substantive change in the industry, whereby companies are in-housing semiconductor design (auto, defense, hyperscalers, telecoms) creating specialized chips (ASICs) to differentiate their own products/services and create economies of scale given their increasing silicon consumption/product percentage. Meanwhile, the development of semiconductor IP is increasingly being outsourced, especially for complex niches like SerDes.

As such, in-housed design work is moving from internally developed components to high level integration activities similar to contractor/subcontractor work, essentially mixing/matching IP blocks from outside vendors and relying on design houses for specialized/difficult work. This style of design (integration) work is employed most aggressively with data infrastructure entities, as they require highly specialized silicon solutions in greater numbers than most other industries.

Chip complexity and higher costs are driving these customers to create/adopt chiplet designs, connection of multiple single process chips at various nodes to replicate a single, large, expensive System on a Chip (SoC). This increases the importance and content percentage of connectivity IP for a new design.

Customer contracts can vary widely on fees and royalties. License fees for IP blocks can be $2M-$5M while more integrated/complex connectivity IP or solutions can generate $15M-$20M per instance. These licenses can be for the technology or just the architecture. Fully designed chiplets integrating AWE IP can generate $30M-$50M in fees. Royalties can be $/unit and/or percent of ASP (2%-3% on the high end).

Customer cycles are typically 6-9 months of assessment, followed by up to 2 years of customer R&D to determine final design, followed by product launch with 5-10 years of life for a single product. Notably, data infrastructure hardware designs have a longer life span (5-10 years) than mobile/PC markets (2-3 years).

Revenue as per this cycle is as follows - NRE's, license/support fees during a customer's R&D period, followed by royalties and support fees once a product is manufactured and unit volumes ramp. The hardest part of the sales cycle is getting spec'd into a design, afterwards a long tail of royalties should be expected throughout the life of the final chip.

The engineering difficulty coupled with the need for performance differentiation results in connectivity IP garnering a premium in the market and strong demand from a wider range of customers, even the top semiconductor firms, as they focus on other elements of a chip.

As such, Alphawave should durably leverage their position to generate revenue/returns as customers have little choice if they require the highest speed solutions in the market. Additionally, products with long life spans in the data infrastructure market should bolster revenue levels for longer than most other IP firms tied to mobile or PC trends.

For OpenFive, an ASIC third-party design firm would be used if the customer is a non-semi company looking to simply subcontract out and integrate, or a semi company lacking a particular expertise/looking to double check design work. Data intensive customers, whose switches and other data transfer hardware may comprise 80%-90% wired connectivity IP may simply outsource the entire design to an AWE and focus on manufacturing and selling the product.

OpenFive's agreement with SiFive to allow use of RISC-V IP is an additional benefit as customers are adopting this architecture for AI/ML workloads. Its open-source programming is also perfectly suited to heterogeneous chip integration via chiplets.

Third-party design firms are gaining share in the industry as time to market for new products pushes design teams to the limits and the cost of fixing a design error increases by a factor of 10 once the chip is on silicon and in production. Fully spec'd designs with the best-in-class connectivity IP should ease sale of IP, obtain greater wallet share in a chip program and speed time to market for customers.

Supplier Dynamics: SerDes a niche in the industry with limited supply of engineers; best locations Canada/UK

Alphawave's inputs and keys to performance are engineers with a specialty in analog and mixed-signal analysis/design. Throughout the semiconductor industry, analog disciplines (understanding physical phenomena and translating that to digital signal) amount to a small subset of practitioners, while most of the industry focus is on digital chips.

On top of that, SerDes, AWE's core technology base, is increasingly niche by dealing with the physical layer on the silicon itself (PHY). This lack of supply is also another factor in why many customers outsource SerDes IP.

The company's location in Canada/UK is partly driven by its proximity to the supply of these engineers from a few key universities as well as other semi IP firms. Not to mention AWE's sourcing is more cost effective versus competing for engineers in Silicon Valley. Should demand increase for said engineering disciplines, the cycle time is at minimum 4-5 years for students to graduate university, and likely even longer as they require further training post-graduation.

For chip design, supply of engineers is more widespread, while niches in connectivity and RF exist.

Of the ~600 Alphawave employees, R&D engineers constitute over 85% of the total and ~300 design engineers are in India. Similarly, R&D comprises ~80% of AWE's stock-based compensation.

Competitor Dynamics: Differentiated DSP-platform and SerDes focus quickly carved out leadership position; pro forma OpenFive entrenches IP into designs; fewer large rivals

SerDes is a difficult, highly niche domain with a limited supply of engineers and competitors. The wired connectivity IP market is ~70% outsourced as very few big firms develop their own IP.

The biggest companies in wired connectivity IP are Synopsys and Cadence followed by Rambus. Notably, SNPS and CDNS have wide ranging portfolios and are not focused on wired connectivity, while Rambus has what is considered trailing edge solutions in comparison to Alphawave and more focused on memory interface IP.

Importantly, the methods of traditional SerDes, utilizing purely analog techniques, limit the economic scalability of IP solutions as typically a wired connection IP would be created for an individual use case and would not be widely reusable. This results in a highly R&D capital intensive business lacking scale, of which only a few competitors allocate capital towards.

As transistor sizes have shrunk below 7nm, wired connections in and between chips exhibit increased EM interference and have become the limiting factor in data transfer. Compounding the issue, increasing transfer speeds also amplify signal integrity and power issues. Given these demands, SerDes solutions for the leading edge require mixed-signal technology, using digital signal processing to scale the data transfer stream at smaller nodes.

Most competitors are behind in their utilization of DSP, and/or lack the resources. With a 'DSP chassis' that allows for configurable wired solutions, Alphawave can not only maintain its advantage but also generate economics superior to competitors. Further, DSP-based connectivity allows for faster time to market for AWE's customers.

Notably, Credo Technologies, a recent US SerDes IPO with very similar dynamics/markets/IP to AWE, only has solutions down to 7nm coupled with inferior margins.

By virtue of this DSP structure Alphawave was the first mover at the 112G rate (with design wins at the 5, 4, 3nm transistor nodes), jumping ahead of Synopsys, the previous leader, and Cadence. With most of the top semiconductor companies and a handful of the biggest hyperscalers as customers all scaling down to 3nm with speeds based on 224G (likely optical), AWE is in a leadership position to grab additional market share with a DSP chassis that can adapt solutions faster than competitors.

In the ASIC design market, OpenFive competes with a few other outsourced design firms, though differentiation comes down to specific skill set and focus. For OpenFive, their specialty included chip designs for networking and data transfer leveraging connectivity IP and RISC-V architectures via agreements with former parent company SiFive.

By combining AWE and OpenFive, the company can better defend its leading connectivity IP by integrating it into ASIC designs, a capability few IP firms have implemented. This move amounts to a vertical integration and gives AWE an ability to carve out a bigger portion of the custom silicon design market, while making their IP more accessible. Competitors in this realm include Broadcom, Marvell and MicroSemi, who implement similar strategies in the same markets.

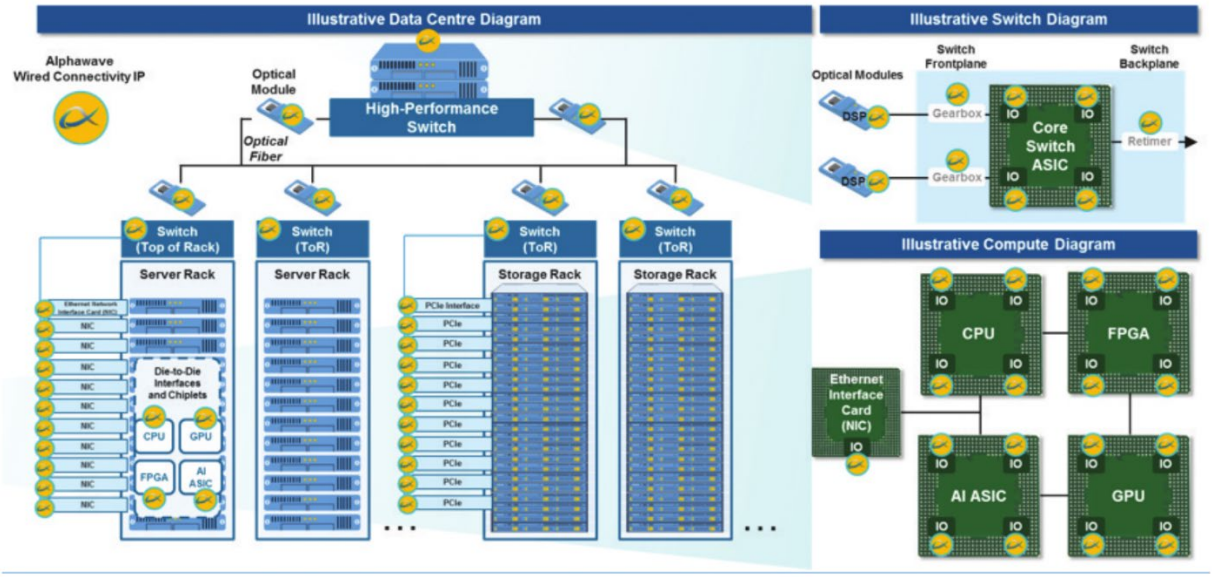
Notably, this AWE/OpenFive combination is a divergence from an ARM-esque IP-only firm, but very necessary given the expansion of new chip architectures and data infrastructure end customers desire for custom solutions. Since SoftBank's purchase of ARM, the company's push into data centers has not created much traction or profits and is a proof point that attacking these markets with just IP tied to a single architecture is not a winning proposition.

Market Trends: Spread of high-speed connection points in data center, 5G infrastructure and chiplet IC design should drive rapid market expansion

Wired Connectivity IP: The number of IP blocks per chip has increased from ~100 in '12 to almost 200 in '21. The market for semi IP is roughly $6B-$7B, ARM comprising ~40% share followed by SNPS at ~20%, CDNS at ~6% and AWE at 3%-5%. The connectivity IP market is ~25% of total IP, of which ~70% is outsourced, and is expected to grow ~14% per annum through '24.

Data Centers: Data center capital spending is expected to grow ~13% per annum to ~$375B by '26 according to Dell'Oro Group. The physical number of data centers is expected to increase ~4% per annum from ~1,700 in '22 to ~2,100 by '27.

SerDes connection points in a data center at the 100/200 Gbps level is expected to grow from several million points today to ~250 million points by '25. SerDes Connection points at the 400/800 Gbps level are expected to grow from several million points today to ~35 million points by '25, according to 650 Group. A helpful illustration of the potential connection points in the data center are shown below.



Source: Alphawave IP.

RISC-V: Importantly, within the data center RISC-V appears to be gaining adoption for AI/ML workloads. Deloitte expects RISC-V to be a ~$1B market in '24. Approximately 70% of workloads in the data center run off Intel's x86 architecture, down from almost 90% just a few years ago as AMD and others take share. Semico Research believes that RISC-V architectures could be in 20+ billion chips by '27, up from today's billion or so.

5G Infrastructure: 5G connection points are expected to grow over 30% per annum from ~1.7 billion in '22 to ~4.5 billion by '25, according to IDC. Mid and back-haul portions of the 5G infrastructure market, which would be serviced by wired connectivity solutions are expected to grow similarly. Overall spending towards 5G infrastructure is expected to increase from ~$12B in '21 to ~$115B in '26 according to Market Research Future.

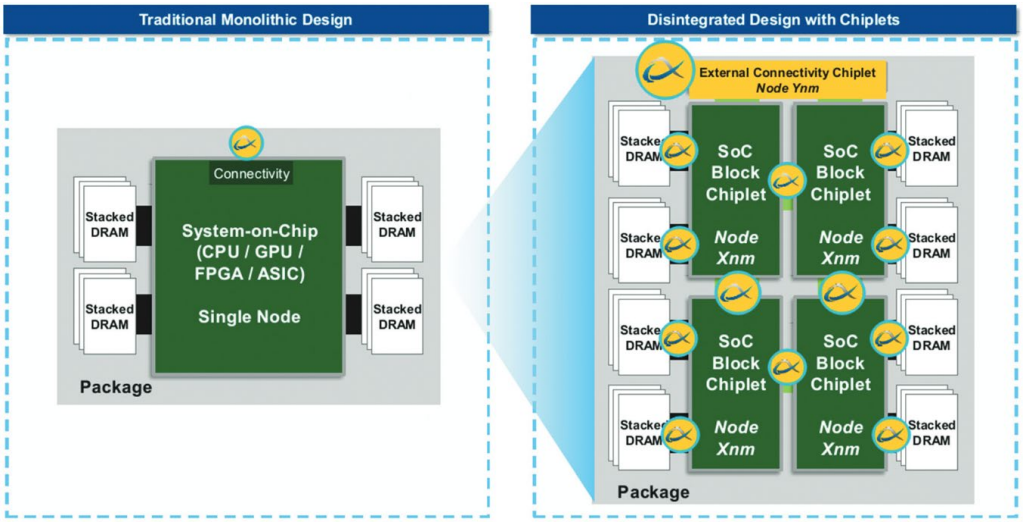
HPC/AI: AI server growth is expected to increase from ~$20B in '22 to over $30B in '25 according to IDC.

Custom Silicon Design: Custom silicon market is expected to increase from ~$5B in '22 to over $20B in '24 according to IDC.

Chiplets/UCIe: Increasing chip complexity and cost started in earnest at the 28nm node, where cost per 100M transistor gates stood at $1.30, and escalated up to $1.52/100M transistors at the 5nm node. Overall manufacturing costs increased 4x from 45nm to 7nm nodes, while SoCs utilizing those nodes have gotten even larger creating yield issues at the wafer level.

Chiplets attempt to lower costs by having different components of a SoC at varying technology nodes and connecting them together. For example, a chiplet might have 5nm CPU cores connected to 22nm I/O with a high-speed interconnect.

For a SoC, wired connection points may be only one IP block from the package to the server. With chiplets, every component in the package would have its own interconnect and IP block, increasing the connectivity IP blocks by factors of 5 or more depending on the design. An illustration of the expansion of connection points within a SoC vs chiplet are shown below.



Source: Alphawave IP.

The overall chiplet market is expected to grow from ~$5B in '22 to ~$50B in '24 as the methodology matures. Driving this adoption is the acceptance of the Universal Chiplet Interconnect Express (UCIe) specifications by the three major foundries as well as Google, Microsoft, ARM, AMD and others.

Semiconductors: Last year, according to the SIA, there were over 1.15 trillion semiconductors sold, a ~13% increase y/y. Of the roughly $550B in semiconductor sales last year (up ~26% y/y), ~$135B (~25%) were data center and wired infrastructure end markets.

3) Why now?

Alphawave's unique value proposition to the industry has started to gain significant traction with some of the biggest data-centric companies in the world, while the share price continues to languish as it reflects a multitude of fears including a misplaced one on related parties. With the acquisition of OpenFive, the company is in a place to not only allay many of those fears but entrench itself in the high-speed segment of the data infrastructure market by providing higher value designs with leading edge IP. Pro forma the acquisition, the name trades at ~4.5x EV/'23 EBITDA, even assuming the WiseWave contract expansion does not occur (which was telegraphed by management already), a moribund appraisal considering that semiconductor IP/design firms are typically valued at 10x-20x. We advocate

entering into a position as the company's core IP business inflects upwards as customers won during '19-'21 ramp production/adoption of AWE-backed semis, the OpenFive acquisition creates multiple paths to value creation while derisking many of the fears about the business, Chinese revenue declines in materiality and the market lags in catching up to the accelerating/improving story.

A few key points below illustrate the company's value potential at this point in time:

1) **S-curve of adoption for Alphawave IP from blue-chip firms starting in full in '23, should drive rapid growth in revenue in excess of macro conditions and add legitimacy to the business:** In early '20, Alphawave had 10 customers, which should expand to ~30 by late '22 (excluding OpenFive). Typical design cycles for chips are roughly two years, and the 3x increase in customer base should equate to significant revenue growth from '22 to '24 as the final products go into production/use. This is driven by AWE's first-to-market IP wins ($2M-$5M licenses) at the 7nm-3nm node and corresponding 10x increase in adoption of 112Gps SerDes in data center switches/chips over the next few years. Chiplet IP wins ($15M-$20M licenses) starting in late '21 should exhibit a significant increase in wins coming in late '22 bolstering revenue growth through '24. The next SerDes node is at 224Gbps, which Alphawave has a head start on, and is also expected to ramp similarly in the data centers from '25-'27. Early IP design wins came from China and a few related parties, however, new customers since include North American blue-chip firms such as Google, Microsoft, Amazon, Broadcom and Cerebras. Given the trajectory of the NAM business coupled with slowing Chinese involvement and the acquisition of OpenFive, NAM revenue should increase to 60%-70% and Chinese revenue exposure should drop from 30%-40% in '22 to 10%-15% in two years. Further proving out AWE's legitimacy, the firm was awarded Partner of the Year by TSMC in mid-'21, partnered with Samsung foundry in late '21 and Intel in mid-'22. As such, Alphawave has guided to $325M-$360M in '23 (32%-36% EBITDA margins), ~$500M in revenue (40%-45% margins) in '24 and $1,000M in '27 including OpenFive, approximately 30% per annum growth. While appreciating the dynamics underpinning this growth and management's ability to execute, we assume the company lags by a year in their projections, reaching ~$450M by '24 and ~$850M by '27, which at today's valuation equates to ~2x and ~1.5x EV/EBITDA, respectively (~2.5x and ~1.75x EV/FCF).

2) **Integration of OpenFive should create multiple avenues of value creation as Alphawave solidifies market position with fully designed chiplets:** OpenFive's complementary IP portfolio, capabilities of delivering custom SoCs, and significant customer base, give Alphawave considerable paths toward value creation going forward, irrespective of current market conditions. The 2x increase in IP products allow for greater wallet share within a design, increasing sales efficiency. A 300+ person design team working in tandem with customer R&D teams gives AWE greater access that is higher up the value chain, increasing customer stickiness and facilitating more AWE IP into silicon generating $30M-$50M per design as opposed to $2M-$5M per IP block. Further, a near 3x increase in customer base to ~80 firms should provide Alphawave with an easier cross-sell opportunity, considering Alphawave is spec'd into only a handful of designs. At a higher level, this combination expands AWE's markets from IP (several billion) into the chiplet design (~$50B) and the custom silicon markets (~$20B), with a competitive position entrenched by their leading IP. Lastly, ASIC design work is more closely tied to less cyclical customer R&D

spending, which affords AWE greater visibility into their end markets, and when at maturity, an earnings engine capable of dampening out changes in royalty revenue during industry cycles. The company was purchased for $210M (~$140M in revenue) equating to 10x-12x EV/EBITDA. OpenFive has lower operating margins (10%-15%), and integration costs should lower Alphawave's '23 EBITDA from 50%-55% margins to 32%-36%. However, once AWE scales in its larger markets, margins should inflect upwards to 40%-45% in the near term and likely reach ~50% at maturity.

3) **Impressive free cash flow generation from superior margins and capital light structure:** Alphawave should generate normalized EBITDA margins more than 45% even with R&D expenses 30%-40% of revenue. This is a function of high gross margins from their scalable DSP-based IP and small SG&A expense given the business model is not sales intensive, only R&D intensive. Additionally, the company is not capital intensive either, as capex is usually only 1%-3% of revenue. As such, Alphawave generates substantive free cash flow even this early in its life cycle without the benefit of large amounts of royalties that exhibit incremental margins of 100%, which are expected to become material in the '24-'25 timeframe. We anticipate FCF margins of ~35% in '23 conservatively increase to 40%+ in '28, generating a cumulative ~$1.5B in cash, almost 2x Alphawave's current enterprise value.

4) **Unique founder-led management team key to maintaining technical advantages through cycles, significant 'skin-in-the-game':** While at Intel the three AWE founders received limited support for a DSP-based SerDes, and thus left to start Alphawave. Clearly, the team has achieved success and displayed technical excellence by winning contracts from the best in the industry, against long-tenured incumbents. Further, their extensive experience through industry cycles has shown through by their strategic positioning of the business and their employment of sound capital allocation practices. The intent of the IPO was to generate capital to acquire businesses to boost the market presence of their core IP before/at the time of mass adoption of the 112G SerDes technology in the datacenters/5G networks. Acquisition wise, Alphawave bought Precise ITC, giving them more datacenter connectivity IP in a key technology (optical), and OpenFive, one of the largest independent custom silicon design firms, which was a stranded asset inside SiFive due to an ill-thought-out acquisition just two years prior. The next node, 224G, will likely require more complex solutions, putting AWE in pole position for the next adoption cycle with the right management and assets. We believe this caliber of leadership derisks terminal value risks surrounding potential technological obsolescence. Since the IPO, the three founders have not materially sold down their ownership, even a year after the lockup expired, owning ~40%. Their involvement is key to the future of the business and their incentive structure is clearly aligned with shareholders.

5) **Reduction of Chinese revenue and exit of investor WiseWave derisks ownership as well as operational and regulatory concerns:** Post-CFIUS approval for AWE's purchase of OpenFive, WiseWave and the company came to an understanding that their partnership and joint ownership should be downsized to a purely commercial relationship. WiseWave has already begun rationalizing their AWE equity position from ~7% ownership to ~4%, with the likelihood of fully exiting the name in a year or so. Further, WiseWave will not exercise its $105M (over three years) expansion but will keep to its original

subscription license deal, the remaining term amounting to ~$44M in '23 (including VeriSilicon). Additionally, Alphawave's capital commitment to the JV of ~$170M (~$30M spent already) will be suspended, and AWE could possibly sell their interest in the JV in the future. While a ~4% position isn't substantive to cause issues upon the selling of the investment, WiseWave's exit should allay investors and regulators concerns given rising geopolitical tensions. Lastly, effective restrictions on the Chinese semiconductor industry would simply accelerate the already declining materiality of AWE's Chinese revenue. An outright elimination of Chinese sales would represent a worst-case scenario but a potential 'clearing' event for the name as the geopolitical risk can only get written down to zero once and the country's future value contribution to our Base Case valuation is expected to be ~20% and a decline in excess of that would be an opportunity.

6) **Strategic position within the industry and a unique platform creates possible acquisition target:** The team that founded Alphawave has experience building up a company and exiting via sale. Snowbush was sold to Rambus and V Semi was sold to Intel. AWE has a lead on competitors in a niche that few appear willing to commit substantive capital towards, with a business structure around the DSP 'chassis' that makes any replication by competitors difficult and years away, all of which ultimately makes the company a desirable acquisition target. A mini-Marvell/Broadcom with a pure-play focus on connectivity IP/designs may be of interest to said companies, private equity or a SNPS/CDNS. A separate note should be made for Intel, who is under pressure to gain share back in the data center, as AWE/OpenFive are both in their Accelerator program and the management team have a history selling to them. Precedents listed below show substantive value to a strategic earns a premium price on normalized valuation multiples, while private equity purchases set a floor on IP assets which are still well above AWE's current valuation.

4) Concerns/Thesis Pressure Points

Technological Risk

Alphawave's value proposition to the marketplace is determined by the performance of its technology. Poor technology can introduce terminal value risk that can overwhelm any discount to peers. Considerable amounts of R&D capital must be expended to maintain a position in industry and management must be on top of the spending/technology cycles occurring in industry. The company's leadership have shown a clear understanding of these dynamics with a two-decade long track record to prove it, despite their current business's young age, which we believe reduces this risk.

Data Center/Network Spending Risk

Alphawave's market exposure to data centers/wired network infrastructure is ~75% of their revenue/pipeline. While their solutions are being adopted in the data infrastructures upcoming hardware cycle, which should last several years, the company's revenue at maturity would be tied to the level of capital spending in these industries. IP competitors face this issue at maturity with high margin revenue cycling with their end markets and with little

visibility. Offsetting this dynamic for AWE is the acquisition of OpenFive as ASIC design work is tied to less cyclical customer R&D spending (similar to IP NRE revenue).

Substitution Risk

SerDes is foundational to chip data transfer and has been a core technology since the 90's with little to displace its dominance. Alternatives to SerDes connective solutions are monolithic integrations, which the company does have IP for, but should designers opt to simply directly connect chips together this would reduce AWE's addressable market. There are multiple issues associated with monolithic integration (clocking issues, EM interference), which limits its usefulness. Additionally, a shift back to parallel I/O could result in similar reductions in markets. However, even parallel connective design essentially embeds a mini SerDes, unlike in the past.

Competition/Replication Risk

Although a node ahead of competition, industry participants are not standing still and are developing 112G/224G SerDes solutions as well. As noted above, continual R&D spending is required to keep pace in the market. Further, the unique DSP 'chassis' that AWE is built around is, on paper, replicable. However, potential competitors such as Synopsys and laggard in SerDes IP, Cadence, are more focused on EDA markets with IP a secondary selling point to ease pain points for EDA customers. Also, to compete on par with Alphawave would require a complete rearchitecting of a competitors SerDes R&D team and IP portfolio, which could take years to prove out on personnel (need the right engineers) and technical basis.

Chinese Exposure/Restriction Risk

AWE's Chinese revenue exposure (now 20%-25% pro forma) subjects the company to the tensions between China and the West regarding leading edge semis. While revenue exposure is expected to drop into the 10%-15% range by '24, a global coordinated ban by the US and others on certain technologies could have that exposure drop to 0% quickly with little to no warning. New US restrictions, announced October 7, could limit China's ability to manufacture leading edge semis by blocking export of US-based tools (logic 16nm or less, NAND 128 layers or more, DRAM 18nm half pitch or less). China accounts for ~25% of global WFE, of which 50%/50% is manufactured by domestic vs multi-national firms, and ~20% of the Chinese WFE is leading edge. In the event of a total ban, we have estimated that the elimination of Chinese revenue in '23 would reduce our fair value expectations by 20% (detailed below).

M&A Integration Risk

The company was built from the ground up only a handful of years ago, and has limited operating history, and even less of a record as a public company. Since the IPO, AWE has purchased a tuck-in IP firm, Precise ITC, and recently a much bigger, industry adjacent firm, OpenFive. This introduces operational risks namely around customer

retention, the integration of R&D efforts as well as revenue synergies from cross-selling. Notably, management does have solid operating experience from previous private companies.

FX Risk

While domiciled in the UK and share prices in GBP, the company's financials are in US dollars, with significant overseas exposure in Asia. Further, the majority of their cash balance is in GBP, a currency which has suffered declines to its lowest level to the US dollar since its creation in 1790. Lastly, when comparing multiples, its critical to ensure that financials and market data are in the same currency.

5) Business Valuation

Alphawave should embark on a multi-year period of 20%-30% per annum growth as their IP products, which have already been spec'd in with many blue-chip firms, gain adoption in the data centers and mid-back haul wired segments of the wireless networks. Another component of this growth is the rapid industry adoption of chiplet designs, which massively increase the number of connection points within a chip, and therefore opportunities to sell connectivity IP licenses. Preparing for this next technology ramp up, the company purchased a custom silicon design group, OpenFive, allowing them to not only increase their addressable market in chiplets but also increase share of their IP by facilitating an easier sales process with the largest customers in the world. The firm generates revenue through the sale of IP licenses (NREs, royalties, support/maintenance), and silicon design services.

A summary of the Base Case assumptions for the company is below:

1) Short-Term Guidance: '23 Revenue: $325M-$360M, '23 EBITDA margins: 32%-36%.
2) Long-Term Guidance: Organic Revenue: ~$500M in '24, ~$1,000M in '27. EBITDA margins: 40%-45% in '24.
3) Revenue should grow ~22% per annum to ~$450M in '24, ~$850M in '27 and ~$950M in '28. We expect royalty revenue to come on stream starting 2H/22 and amount to ~20% of total revenue by '28, and cross-selling of AWE/OpenFive normalizes by '26.
4) EBITDA margin should inflect upwards from ~35% in '23 to 40% in '24 and ~49% in '27 due to scale and royalty revenue with 100% incremental margin.
5) Capex: ~3% of revenue in '22/'23 scales down to ~2% thereafter.
6) AWE has no debt and ~$200M in cash pro forma OpenFive acquisition.
7) ~15x normalized EV/EBITDA or ~17.5x EV/FCF multiple for Alphawave. Reasoning behind the multiple is in the Peer Analysis section below.
8) Discount rate at ~15% (small-cap).

Five-Year Operating Model

A simple five-year operating model is utilized to determine value.

Base Case: Base Case assumes the company grows to ~$950M in revenue by '28 with EBITDA margins in the high 40%'s, on a 15x EV/EBITDA valuation (~17.5x EV/FCF). Equating to a ~38% per annum IRR over five years.

- Base Case Valuation: **£575p/share.**

Upside Case: Upside Case assumes the company reaches maturity at a ~$3.5B revenue run rate roughly half of MRVL's revenue, capturing ~5% market share of their ~$70B addressable market, at a valuation on par with Marvell (~25x EV/FCF). Equating to a ~82% per annum IRR over five years.

- Upside Case Valuation: **£2,300p/share.**

Downside Case: Downside Case assumes the company grows less than 10% per annum to ~$500M by '28, does not increase EBITDA margins beyond ~35% and is valued at a ~10x EV/EBITDA (~11.5x EV/FCF). Equating to a ~14% per annum IRR over five years.

- Downside Case Valuation: **£225p/share.**

A summary of the valuation in each of the three cases is below ($), including scenarios where all Chinese revenue and expected growth is zeroed out starting in '23:

Potential Range of Outcomes			
Case	**Upside**	**Base**	**Downside**
Valuation	£2,300p	£575p	£225p
Return	1,883%	396%	94%
IRR	82%	38%	14%

Potential Range of Outcomes ex. China			
Case	**Upside**	**Base**	**Downside**
Valuation	£1,900p	£475p	£175p
Return	1,538%	309%	51%
IRR	75%	33%	9%

Peer Analysis

Trading Comps

Alphawave has a few direct public comparables in its hybrid IP/design state, Broadcom and Marvell, as well as a few IP-only firms given most of their revenue is still derived from the sale of licenses (CRDO, CEVA, RMBS). While Synopsys and Cadence (~20x normalized EV/EBITDA) are IP competitors their earnings are predominantly derived from their EDA solutions, thus making for a poor comparable. The list of comparables below consider both the business models listed to triangulate a fair valuation utilizing a conservative EV/EBITDA framework, as EV/FCF generates a greater valuation and there is an attempt to remain conservative.

Further, peer valuations during the Covid timeframe (March '20 to early '22) were handicapped where possible to avoid inflated valuations (ex. MRVL trading as high as ~34x EBITDA in late '21, ~2x pre-Covid levels). Lastly, in the case of ARM Holdings (ARMH), the company's period of being public was not used to triangulate a fair value for AWE, to further embed conservativeness as the firm traded between 18x-33x EV/EBITDA from '12 to '16, ~25x on average.

Public Comparables – EV/EBITDA

1) Broadcom (AVGO) – ~10.5x normalized EV/EBITDA; currently at ~9.5x FTM.
2) CEVA, Inc (CEVA) – ~15x normalized EV/EBITDA; currently at ~11.5x FTM.
3) Credo Technologies (CRDO) – ~15x normalized EV/EBITDA; currently at ~13x FTM
4) Marvell Technology (MRVL) – ~16x normalized EV/EBITDA; currently at ~15x FTM.
5) Rambus (RMBS) – ~9x normalized EV/EBITDA; currently at ~9x FTM.

Broadcom designs, develops and supplies semiconductors in broadband, networking, wireless, storage and industrial markets. The company also provides infrastructure software amounting to ~25% of sales. Revenue growth should average ~5% per annum over the next five years as the business is mature.

CEVA licenses IP of digital signal processors, AI processors, wireless solutions and software for mobile, IoT, computer vision, and AI applications. Over 45% of revenue is derived from royalties, the remainder from license sales and over 60% of revenue tied to China. Growth should average ~15% per annum over the next five years.

Credo Technologies is a high-speed wired connectivity IP provider for the data infrastructure market, offering SerDes solutions for ASICs and chiplets as well as optical products. Notably, this is one of the competitors most cited as a comparable for AWE and IPO'd in early '22. However, CRDO latest contract wins are only at 7nm reinforcing the view of Alphawave's market position. Further, the company's Chinese revenue amounts to 60% of the total, almost double AWE's current exposure and two of its customers make up over 60% of revenue. Credo's revenue is expected to more than double in two years.

Marvell is a supplier of high-performance data infrastructure semiconductors and recently purchased Inphi, a high-speed data infrastructure semiconductor firm with a niche in optical interconnections. Notably, the company's revenue composition is ~45% from China. Growth should average ~15% per annum over the next five years given its over indexing to datacenters and 5G infrastructure.

Rambus provides IP of memory chip interfaces, SerDes PHY's as well as digital controllers and security IP. Approximately 45% of revenue is from royalties and ~50% of sales are in memory IP to Micron, Samsung and SK Hynix. Growth should average ~10% per annum over the next three-to-five years.

The group's normalized EV/EBITDA multiple equates to ~15x and has ranged between 7.5x-25x from '16 to '22 and currently trades at ~11.5x FTM assuming 10%-15% per annum revenue growth. Alphawave currently trades at ~4.5x EV/EBITDA and should exhibit growth in excess of 20% per annum for the next five years.

Peer Analysis – EBITDA Margins

1) Broadcom (AVGO)– ~60% normalized EBITDA margin; currently at ~57.5% FTM.
2) CEVA, Inc (CEVA) – ~25% normalized EBITDA margin; currently at ~25% FTM.
3) Credo Technologies (CRDO) – ~32.5% normalized EBITDA margin; currently at ~20% FTM
4) Marvell Technology (MRVL) – ~42.5% normalized EBITDA margin; currently at ~40% FTM.
5) Rambus (RMBS) – ~50% normalized EBITDA margin; currently at ~40% FTM.

Broadcom's margins should inflect upward slightly as their infrastructure software sales continue growing at a ~90% gross margin and semi solutions maintain its ~70% range. Capital expenditures should average 1%-2% of revenue.

CEVA's ~80% gross margins are expected to factionally increase with greater royalty growth. However, EBITDA margins are expected to stagnate given R&D intensity and lack of scale. Capex should average ~2% of revenue.

Credo should experience operating margin expansion from high-teens- 20% up to 30%-35% as their royalties grow and the firm leverages its opex. Capital expenditures have averaged 10%-15% of revenue.

Marvell's EBITDA margins are expected to increase from a normalized 25%-30% to 40%-45% following the integration of Inphi as the company realizes large cost synergies. Capital expenditures have averaged ~4% of revenue.

Rambus's operating margins have increased substantially from 25%-30% in '17 to ~40% in '22 with a near term target of 50% as memory royalties come on stream. Capital expenditures have averaged ~5% of revenue.

Alphawave's comparable group generates ~42.5% normalized EBITDA margins, with significant margin expansion for smaller IP firms. Additionally, hybrid firms that Alphawave is modeling itself after, AVGO and MRVL, exhibit EBITDA margins of 40%-60%. Alphawave should generate 32%-36% EBITDA margins in '23, which should expand into the high 40%'s in a few years as their design segment gains scale and royalties come on stream from the adoption of chiplet solutions.

Strategic Acquirer Analysis

Alphawave's management have a track record of selling their companies, representing a possible exit for AWE, and recent transactions show the value to financial and strategic buyers:

1) ARM Holdings (ARMH to Softbank, '16) – $31B purchase price, 50x+ EV/EBITDA (45%-50% margins).
2) ARM (ex.IoT) (Softbank to NVDA, '20) – $40B purchase price, ~63.5x EV/EBITDA (~35% margins), ~22x EV/Revenue (never consummated due to antitrust issues).
3) Imagination Technologies (IMG LN to Canyon Bridge, '17) – $685M purchase price, ~25x EV/EBITDA (~20% margins), ~4.75x EV/Revenue.
4) Inphi (IPHI to MRVL, late '20) – $10B purchase price, ~68x EV/EBITDA (~20% margins) ~35x EV/EBITDA including cost synergies, ~15x EV/Revenue.

While Softbank cannot be considered a reasonable buyer and its purchase of ARMH in '16 should be handicapped, it's clear that financial buyers are the lowest bidders for semi IP assets with EV/EBITDAs in the 25x and up range. The value to industry competitors is much higher, given strategic and cost synergies with EV/EBITDAs in the 35x and up range. If one were to haircut these precedent transactions by 50%, it would still indicate valuation multiples 2x-3x higher than AWE's current market pricing.

Valuation Conclusion

For Alphawave, a ~15x EV/EBITDA normalized valuation appears conservative based on the representative comparable group of semiconductor fabless and IP firms with similar markets/business structures. Even firms with greater Chinese exposure, a demonstrably lower level of technological leadership and lower margins have valuations 2x-3x higher than AWE. Notably, if the firm does become similar to ARM in market dominance but for data infrastructure end markets, a comparable 20x-25x EV/EBITDA multiple would be considered reasonable.

While not discussed in full, comparable company analysis on an EV/FCF basis yields a fair value at ~25x. Interpolating AWE's normalized EBITDA multiple and margins of ~15x and ~49% to its FCF margins of 40%+ yields an EV/FCF multiple of ~17.5x, a ~30% discount to peers. Given the business model variances and an eye towards conservative valuations, we opted to utilize EV/EBITDA.

6) Market Expectations/Perceptions

Alphawave is covered by three analysts with an average price target of ~£260p/share, all with Buy ratings. Estimates do not go beyond '23 despite positive commentary on the company's growth and technology. Sell-side analysts do not seem to give the company much thought beyond a few paragraphs per update. One Sell-side analyst does not even properly understand the business, highlighting risks that AWE is not exposed to and overemphasizing growth drivers that are not the real determinants of performance.

A modest contingent of the investor community believes AWE to be a fraud or rife with accounting schemes (neither of which have validity) tied to the dated and largely disproven 'hit piece' published in September '21. Further, many believe that the company's revenue trajectory is currently tied to overall data center spending, which many expect to be flat in '23. In actuality, AWE's revenue should still inflect upward in a more benign spending environment given the emerging adoption of the latest 112G technology in the data center. At maturity, it can be accurately said that Alphawave's revenue is tied to data center/infrastructure capital spending.

Lastly, AWE's UK domicile may mask its largely North American culture (and soon earnings exposure) to US investors, who usually avoid European firms.

Consensus forecasts in the near-term include the OpenFive deal around the midpoint of guidance. The largest underlying disconnects are likely the now, minimal, related party connections, Chinese ownership/revenue exposure and the limited trading liquidity.

7) Downside Protection – Where's the Margin of Safety?

The company's downside is well protected as Alphawave is already spec'd into over 20 initial customer designs and is one of only 2 or 3 competitors with SerDes solutions down to 3nm making it a valuable acquisition target. Alphawave is free cash flow positive with FCF margins in the 35%+ range, no debt and a cash balance (pro forma OpenFive) amounting to almost 30% of its current market cap. Further, insiders have added to their position in the £120p-£140p/share range.

The company currently trades around 4.5x EV/EBITDA, while private market comps put similar IP firms with technology leadership in the 25x+ range. Should the company be acquired for 25x EBITDA on current financials the valuation would equate to ~£425p/share (~265% upside), or ~4% above its initial IPO price of £410p/share.

Should the company fail to grow beyond its '23 guidance ($325M-$360M revenue, 32%-36% EBITDA margins) and still be valued at the current market multiple, the company would be worth ~£200p/share, ~70% above today's share price.

Adjusting growth and margins to '23 consensus estimates imply a normalized ~2x EV/EBITDA valuation for the business based on the current market price of ~£116p/share, highlighting the mispricing of the business even its early-stage form.

Alphawave appears to already discount many investor fears with current valuations in the single digits, which is in itself a margin of safety, despite a legitimate growth trajectory that should ramp in the next 12 months and Chinese ownership/revenue exposure rapidly declining in materiality.

8) Conclusion

Alphawave is an evolving IP firm leveraging its technology advantage in wired connectivity to take advantage of three market inflections: the adoption of 112G in data centers and 5G mid-back haul markets, the expansion/outsourcing of custom silicon designs, and the adoption of chiplets throughout semiconductor end markets. The company's purchase of OpenFive, while varying from its original analogy as the ARM of data infrastructure but much more akin to a Marvell or Broadcom, opens it to a much bigger market than most expect, and allows the company to entrench its IP more thoroughly in the industry with greater customer/earnings durability and visibility. All of which lowers cyclicality and terminal value risk normally associated with IP-only firms.

The company's valuation should inflect upward as the chiplet IP and custom silicon design wins are announced, Chinese investors exit, Chinese revenue declines in materiality and trading liquidity improves (likely from the previous points, but also possibly due to a US listing).

As of October 12, 2022, the name is trading at £116/share. With a Base Case valuation of **£575p/share**, we believe there is **~395% upside**, equating to **~40% annualized IRR over five years.**

Catalysts:

- NAM/chiplet license wins
- Datacenter adoption of 112G/224G
- OpenFive integration
- Chinese semiconductor ban
- WiseWave shareholder exit
- Sell-side initiations
- US marketing
- Possible NASDAQ listing

Sincerely,

_____

Daniel Prather, CFA
Director of Research

Disclaimers

+ Ownership of mentioned companies

We may hold long or short positions in any of the securities mentioned in this report.

+ No guarantee of investment performance

Past performance of the financial instruments mentioned in this report should not be taken as an indication or guarantee of future results. The price, value of, and income from, any of the financial instruments mentioned in this report can rise as well as fall and may be affected by changes in economic, financial and political factors. Any projections, market outlooks or estimates in this presentation are forward looking statements and are based upon certain assumptions. Other events that were not taken into account may occur and may significantly affect their returns or performance. Any projections, outlooks, or assumptions should not be construed to be indicative of the actual events that will occur. Future returns are not guaranteed. If a financial instrument is denominated in a currency other than the investor's home currency, a change in exchange rates may adversely affect the price of, value of, or income derived from that financial instrument. In addition, investors in securities such as ADRs, whose values are affected by the currency of the underlying security, effectively assume currency risk.

+ No guarantee of accuracy

While the information prepared in this document is believed to be accurate, Crossroads Capital, LLC (the "Investment Manager") makes no representation or warranty as to the completeness, accuracy or timeliness of such information. The Fund and the Investment Manager expressly disclaim all liability for errors or omissions in, or the misuse or misinterpretation of, any information contained herein.

+ No obligation to update or act on information

The Investment Manager has no obligation to update any information contained herein, and may make investment decisions that are inconsistent with the views expressed herein. Any holdings of securities discussed herein are under periodic review and are subject to change at any time, without notice.

+ Not a recommendation to buy or sell any security

This report does not provide investment recommendations specific to individual investors. As such, the financial instruments discussed in this report may not be suitable for all investors, and investors must make their own investment decisions based upon their specific objectives and financial situation utilizing their own financial advisors as they deem necessary. Investors should consider this report as only a single factor in making an investment decision. All information provided is for informational purposes only and should not be deemed as investment or other professional advice or a recommendation to purchase or sell any specific security.

+ Not an offer to invest in our Fund

This report, which is being provided on a confidential basis, shall not constitute an offer to sell or the solicitation of any offer to buy limited partnership interests of Crossroads Capital Investment Partners, LP (the "Fund") which may only be made at the time a qualified offeree receives a confidential private offering memorandum ("CPOM"), which contains important information (including investment objective, policies, risk factors, fees, tax implications and relevant qualifications), and only in those jurisdictions where permitted by law. In the case of any inconsistency between the descriptions or terms in this document and the CPOM, the CPOM shall control. The interests shall not be offered or sold in any jurisdiction in which such offer, solicitation or sale would be unlawful until the requirements of the laws of such jurisdiction have been satisfied. This document is not intended for public use or distribution.

+ Other disclaimers

contact@crossroadscap.io
+1 (816) 610-2437

Crossroads Capital, LLC
5440 West 110th Street, Suite #300
Overland Park, KS 66211, United States