Vortis Technologies Ltd.

Prepared by James R. Johnson

THE VORTIS

Interferometric Antenna Array

For

Small Portable Wireless Devices

White Paper

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Interferometric Array Antenna Technology for Next Generation Cell Phone Antennas:
Enables Hearing Aids, Enhances Performance, Reduces SAR, Mitigates Energy Loss to Head

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Array Technology: Next Generation Antennas for Cellular Technology. Enables Hearing Aids, Enhances Performance, Reduces SAR, Mitigates Energy Loss to Head

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Abstract

Vortis Technologies Ltd. (VTL) provides this paper to present arguments in favor of the use of an Interferometric Array Antenna commercialized under the name Vortis for the improvement of compatibility between hearing aids and cellular telephones (HAC) as required by Section 68.4(a) of the Federal Communications Commission's rules governing hearing aid-compatible telephones.

The Vortis is an advanced antenna concept for cell phones that improve performance when compared to omni-directional or semi-directional antennas. When integrated under a set of reasonable design rules, the Vortis can enhance far field gains, reduce near field interaction with the head and hearing aid and provide other improvements of a handset or other wireless devices. The Vortis is a passive, dual element, 180 degree phased end-fire array antenna operating at frequencies tested from 800 MHz to 1950 MHz with positive results that show enhanced mobile handset performance by improving the distribution of radiated energy.

The Vortis can be applied to most handsets to create a unique propagation pattern that reduce RF energy in the lateral near fields toward the head and hearing aid and enhances the RF energy in the far fields longitudinal to the elements. The unique figure 8 patterns of the Vortis results in reduced multipath interference, increased gain in the primary lobes and provides an ideal means for achieving hearing aid compatibility that can improve access to digital cellular phones for hearing aid users. The performance improvements offer a unique competitive advantage for handset makers and service providers (carriers) that do not require significant modifications or changes to pre-existing designs.

The Vortis also offers a quasi diversity configuration that can ultimately be integrated with RF MEMs as part of a front end MIMO structure as a means to advance 3G and 4G technologies designs in today's antennas.

The Vortis is currently produced as a printed element on a PCB and can be produced as a stamped part or a metalized plating process over plastic causing no significant real-estate requirements within the handset. The Vortis is a readily achievable solution available today that may be implemented to address several issues confronting handset makers and carriers. The Vortis may be retrofitted and at similar economies of scale, would cost around the same as existing handset antennas. VTL's third party testing of the Vortis reveals unique and attractive qualities that offer competitive advantages when evaluated with other means or methods having similar goals.

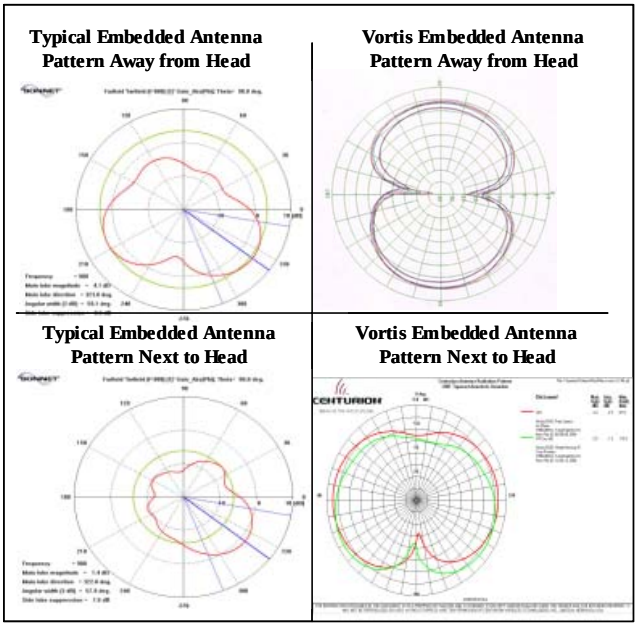
NOTE: It was discovered during testing that the unique propagation patterns of the Vortis actually provide greater azimuthal coverage when used next to the head. This unique new discovery (see comparative wave propagation patterns below) could have significant impact for all users of cellular phones since it offers a low SAR solution, provides maximum HAC performance ratings (exceeds U4 ratings to provide a special rating) and increases gain and efficiency.

Introduction

Hearing Aid and Digital Cellular Phones continue to have radio frequency (RF) interference and electromagnetic (EM) interference and no means to interface with T-Coil pick ups in hearing aids. Technical consortiums, carriers, OEM's and other entities have been studying this issue in order to meet compliance mandates of this multivariate problem. This is the basis for the hearing aid compatibility controversy that has endured for years. There are three primary concerns: (1) radio frequency interference (RFI) noise based on the normal use of a hearing aid with the handset's antenna next to the head within the antenna's near field range; (2) electromagnetic interference (EMI) noise caused from backlighting, liquid crystal displays, power surges within the circuitry or EMI leakage and (3) lack of a telecoil compatible signal generated from the cellular handset. This paper addresses the RFI component of these three critical issues.

VTL is commercializing the Vortis as a means to offer a controlled, localized field strength reduction for the purpose of minimizing radiated field interactions with hearing aids and user's head and hand during normal use of a handset. In contrast to other widely utilized methods, the Vortis does not rely on delicate parasitic coupling of radiating elements for the control of RF energy (directors, reflectors, shields, etc.). The Vortis achieves its benefits by exploitation of active, destructive interference capable of nulls as much as 20 to 40 dBi (1/100 to 1/10,000 reduction in intensity) depending on the host circuit design and surrounding structures. Typically 15 to 25 is expected in most handset form factors. Loading and surrounding environment does cause variation but internal testing has shown these effects can be tuned to meet average goals based on average use. In its current embodiment, two elements may be incorporated on the circuit board, embedded in the handset casing or attached to a handset. These two elements emit two opposite polarity fields so that they annihilate each other in defined regions. Elsewhere, these fields contribute constructively to increase antenna performance.

The illustrations below are radiation patterns typically used to show antenna capabilities when viewing from the top down of the handset. These patterns show power output (farthest from center) of the antenna in a 360-degree range. The images on the left are typical embedded antennas produced by Sonnet Software showing patterns before and after it is placed near a user's head. The images on the right are actual tests results showing significant improvements in radiated patterns using the Vortis.



On July 10, 2003, the Federal Communications Commission (the commission) adopted a Report and Order asking the hearing aid and carrier industry to address this issue partially within 18 months of the order. This order requires a reduction in RF signal toward the hearing aid. VTL's studies were presented to the commission and a petition was filed with the commission for a rule change/clarification contained in Part 24.232, 47CFR24.232, in order to allow innovative use of directional antennas with cellular phone handsets in support of HAC. The petition for rule change may be found in the commission's WT Docket No. 01-309, NPRM related to reexamination of exemption granted to personal communications services devices from the Hearing Aid Compatibility Act of 1988. The commission responded citing no changes were necessary to bring new highly directional antenna technology to fruition.

Advantages of the Vortis:

1. Passive handset solution to HAC with minimal plastics or mechanical changes that can be retrofitted without changes to the manufacturing line and scaleable to the potential user base.
2. Reviewed and generally accepted as an accessory by HAC and access groups around the world.
3. Offers greater azimuthal coverage, gain and efficiency over conventional embedded antennas.
4. Reduces SAR to lowest possible standards if incorporated as a full solution for HAC and SAR.

VTL is seeking to work directly with a handset maker and carrier in support of HAC.

New Look for Cell Phones Create Competitive Advantages

Creating competitive drive by consumers frequently comes from visible technology enhancements. This was apparent in the early 90's with Motorola's new StarTec (the first flip phone). In the late 90's Nokia introduced the first embedded antennas and a surge of new sales was recently experienced with color screens and cameras. Increased market share was a result of visible and practical enhancement technologies. As disruptive technologies, these freshly-conceived products or services threaten the entrenched positions of established market share. With feature rich handsets being released regularly and a diverse, competitive environment becoming more and more fierce, VTL has created the Vortis to reshape energy around a handset and reduce the radiated signal toward the hearing aid and head while improving signal strength, efficiency and performance of a handset by as much as 30%.

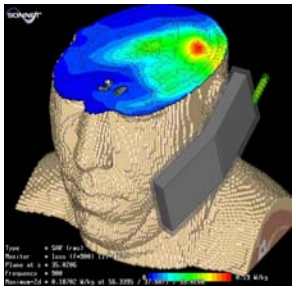
This new handset style will generate excitement with new users and cause on-lookers to take a second look. Early adopter service providers could build a sustainable competitive position on performance, esthetics and compliance.

Sales success for handsets has always depended on the right combination of features, fashion and design esthetics. Battery life, processing power, size and cost are also key drivers that provide differentiation. For new breakout technologies to come to fruition, the design process often takes enormous capital investments and usually requires several years to roll out.

What is the Problem?

The proximity of a handset to a user's head will not likely change for several years. Because of this, the hearing aid and head are found within the near field of the mobile handset's antenna (embedded, whip or helical stubby). This proximity and near field range causes three problems:

1. Antenna coupling with head and hand reduces RF signal performance due to RF energy absorption.
2. Demodulation of the radio frequency (RF) pulses for digital cell phones causes interference sounds in the audio mode of most hearing aids, rendering them useless.
3. Coupling with the head and hand loses energy, heats up the head and requires specific absorption rate (SAR) regulatory limits.



This simulation above by Sonnet Software shows the absorption of energy from a typical cellular handset

Because of this there are severe efficiency losses that cause reduced performance.

1. Signal strength (Gain) is reduced by as much as –1 to -3 dB or more.
2. Efficiency in power usage is reduced by 25% or more.
3. Pattern coverage around the user is reduced by as much as 20% or more.
4. Bandwidth changes due to parasitic coupling with the head cause de-tuning.
5. Range and clarity are reduced proportionately.

Given the rich scattering propagation environments of today's link budgets, these reduced properties and increased directionality are rarely noticed. However, in environments where optimum performance is an advantage or when compared to less capable equipment, performance is noticed.

The Vortis antenna has the ability to reduce near field emissions by as much as 15 to 25 dBi in an idealized form factor with general expected reductions of around 20 dBil toward the head and hearing aid. In addition, the Vortis can provide far field gains of 1 to 2 dB with greater azimuthal coverage for improved uplinks.

Because the antenna reduces RF energy to the user's head using near field nulls, it drastically reduces head and hand interaction making it ideal for HAC and SAR compliance.

Antenna & Vortis Technology

Antenna selection and combining methods have advanced rapidly over the last five years as suppliers and handset makers strive to improve antenna capability, performance, cost, style, and configurations to meet regulatory requirements. Public consortiums and private enterprises have been focusing on new materials, improved modeling techniques, multi-segmented antenna systems and test processes that support the introduction of new technologies. As the industry progresses to 2.5G, 3G and 4G technologies, diversity antennas (spatial, polarization, angular, time, phasing, frequency, etc.) will be utilized more often and across more platforms in order to mitigate signal losses from fading or provide secondary signal pathways that can be combined to increase the paths of RF signal and thus improve data transfer capacity and reliability.

Simple diversity arrays have always been used in base stations in order to mitigate fading as mobiles move about. Intelligent antenna phased arrays are new to the infrastructure and are being tested and implemented. Some handset makers have active antennas operational and ready for launch in specialized niche environments. These IA's will be utilized for beam steering to/from a mobile unit and follow the strongest signal in order to improve the uplink and reduce interference with other mobiles.

Although small mobile arrays have the potential to improve handset performance, these smaller arrays have not been readily achievable relative to costs and spacing constraints. Spacing between elements is limited to the width of handsets, which is generally less than 15% of the wavelengths. Phased arrays operating within these near field constraints usually result in the system becoming strongly coupled due to mutual interaction. If the mutual coupling between elements can be resolved, phased array antennas for handsets could offer several advantages as described herein.

Two antennas, separated by a fraction of a wavelength, can provide sufficient diversity to combat multipath fading. Diversity antennas for handsets may prove particularly valuable for operation inside buildings, where smaller differences in signal-path length are encountered routinely. Based on what's been learned about signal propagation in urban settings, it is believed that equipping handsets with array antennas will provide performance improvements. Technology roadmaps, research and patents of most firms have been focused on array technology as a means to improve reliability in downlinks (base station signals) and uplinks (handset signals). The results of these improvements can produce:

1. Faster data transfer resulting from stronger signal.
2. Improved signal to noise ratios and multipath interference from clearer, less scattered signal.
3. Longer battery life for more efficient energy use.
4. Less interference between handset, hearing aid and human head.
5. Improved regulatory compliance for hearing aid compatibility and SAR.

As array technology focuses primarily on interactive systems using algorithms, DSPs and new chipsets, there is an opportunity to introduce a passive array technology today that will allow the adopter a means to immediately jump ahead of competition while moving closer to the long term goals of array technology.

Linked to one aspect of the HAC resolution is the need to produce a field strength reduction in the near fields substantially to reduce the hearing aid interference. In the FCC's Report and Order for HAC, they wrote: **(2) require certain digital wireless phone models to provide reduced radio frequency (RF) interference (i.e., meet a "U3" rating under the ANSI standard). [ANSI C63.19 Technical Standard]**

The U3 code requires less than 36 - 41 dB(V/m) representing an approximate 10 dB reduction in signal strength. Most handsets operate at around 75 to 150 dB (V/m) at the location of the ear. The highest rating of the standard (U4) calls for a 15dB reduction in energy or much less than the 36 dB(V/m).

The Vortis can provide as much as 20 to 30dB reduction when integrated well. It has been measured to 8 V/m in the peak null for HAC under an ANSI C63.19 test standard and has the potential for greater reductions when tuned effectively. The average reduction is generally sufficient to pass maximum requirements.

Business, Design & Technology Environment

In the arcane world of antennas, innovative engineering companies have created claims about new-patented technologies on all fronts. Greater range, higher reliability, more consistent performance, more reliable uplinks, higher efficiencies (95%), smaller sizes, less ground plane requirements, increased bandwidth (greater than 10%) tailorable-to-application, tailorable directionality, highly localized, smaller near fields (immunity to proximity de-tuning), good impedance matching, relatively good VSWR and of course, reduced costs. Actually meeting all of these requirements simultaneously would, of course, be counter to the nature of electromagnetic physics. Most RF Engineers appreciate this.

Antenna designers ultimately end up compromising a balance between performance, configuration, capabilities, size, cost and regulatory aspects as best as possible. As opposing forces, these aspects are inexorably tied to the design and geometry of the specific handset. When traditional handset designs utilize an interactive approach to antenna designs, a more effective overall program is developed and many claims are realized. However, under certain of today's constraints, many of these claims cannot occupy the same product at the same time nor are they readily achievable in the business environments needed by handset makers and carriers. In addition, claims and specifications are usually frequency-specific that vary with operating ranges.

It is likely that there are nearly 2 million users in the U.S. who will want or require a HAC handset. This could amount to over 6 million globally. Compared to the total user base and over 700 million new handsets sold annually, the HAC number is relatively small compared to other business requirements. However, the impact to HAC users is of far greater value and therefore very much worth the effort given a proper implementation. If a solution for HAC can be combined with a performance enhancement antenna, then the overall value of a HAC solution is substantial to the carrier and handset maker.

New concerns regarding performance and operation of antennas today are focused on measurements against the user's head and hand. This is a new testing protocol. Measurements are executed in a free space environment and most antennas operate under the following general performance requirements:

1. Gain is at around -1 plus or minus 1 dB.
2. Efficiency (EIRP) is around 30% to 50% more or less.
3. Pattern coverage is around 360 degrees but varies in gain which may average out to 320 degrees or less.
4. Transmit and receive bandwidths for cellular frequencies: around 70 Mhz (824-849 xmt, 869-894 rec) and for PCS frequencies: around 140 megahertz (1850-1910 xmt, 1930-1990 rec). Added bandwidth is needed to accommodate world phones operating in Asia or Europe.
5. Return losses for these operating bands are at around 2.5:1 and 3:1 in the receive frequencies giving the transmit bands more efficiency than the receiving.

Full testing includes both free space measurements and measurements using a phantom head and hand. Comparisons with before and after can be performed to show variations in performance at different configurations. 3D testing in anechoic chambers provide recorded power over all the angles to come up with a total effective radiated power (ERP) metric. Drive tests are performed to determine frame error rates and battery usage.

Given the relatively small economies of scale for meeting the HAC requirements, VTL has prepared a plan to retrofit the Vortis into selected handsets under the sanction of the handset maker and carrier. This retrofit program will be executed by a pre-approved ISO 9000 certified supplier for OEMs in order to minimize the supplier management overhead. In addition, VTL has working relations with hearing organizations around the world who

can provide distribution within the hearing channels. It is possible that a handset maker and carrier can have a HAC certified handset available before the end of 2004 with virtually little cost invested.

Hearing Aid Compatibility, Performance Antenna & Carriers

Hearing Aid users comprise around 2% of the total population of the U.S. Nearly 50% to 60% of these users (2-3 million) have a problem using their hearing aids with digital cell phone due to the pulsing signals being processed by the aid's amplifiers. Around 25% of these users will have more of a problem because they can only hear in their T-Coil position, which is worse. This leaves as many as 3 million potential users in the U.S. who need a means to reduce the amount of cell phone RF energy going to their hearing aids. This lifestyle marketing group will number around 1 to 2 million in the US, a very small relative market for carriers, especially when shared over several carriers. Developing a new antenna that would add value for all users has farther reaching impact for a carrier who is an early adopter.

The value proposition to carriers is as follows:

1. VTL can develop a Vortis version for selected handsets as an attachment that will look like its an embedded version rather than an attachment.
2. VTL can support carriers with an internal means to meet compliance requirements with a design, engineering, manufacturing and distribution team of national distributors who can fulfill orders to any level of sales within 90 days and meet customer service and delivery requirements under best business practices and ISO 9000 standards.
3. Open a sales and marketing campaign that will focus on "Hearing Aid Compatibility" and "Performance Enhanced Cell Phones" using the Vortis antenna technology. The advantages are listed below.
4. VTL is currently targeting several OEM's and carriers to provide handsets as a potential partner but is also aware some carriers may desire a single company launch. This does not effect the accessory market although some carriers have made statements that indicate that they can support the accessory.

NOTE: Regarding marketing new antenna technology, although an esoteric field, VTL has found it possible to demonstrate the value of the Vortis within three to five seconds. VTL has created a positive, constructive and powerful means to create a compelling reason to purchasing the Vortis at the point of purchase display. VTL will be developing this proprietary concept simultaneously with the Vortis.

Vortis Advantages & Claims

The Vortis provides a quasi diversity scheme that provides immediate exploitable advantages in handset performance while supporting transitional processes leading into 3G and 4G technologies and Multiple Input Multiple Output (MIMO) implementations. The elements of the Vortis may be converted for use as individual radiating/receiving components of a phased MIMO front end as required for future applications and technologies.

The Vortis offers the following general claims and advantages for handsets over other antenna technology:

1) Mitigates RF interference with hearing aids by mitigating RF near fields toward the hearing aid;
2) Mitigates RF signal absorption by head and hand to exceed health and safety (SAR) standards;
3) Improves azimuthal coverage due to a more symmetrical signal pattern;
4) Increases battery talk time due to greater signal strength requiring less power usage;
5) Clarifies voice and data due to reduced multi-path (time/phase interference) and beam width;
6) Increases signal distance in fringe areas due to 2 to 5 dBil gain in the far fields;
7) Reduces dropped calls from increased coverage and/or gain;
8) Improves antenna efficiency for new air-interfaces due to less interaction with user's body;
9) Speeds up data exchange rate commensurate with gain and signal strength.

With an ability to be metal stamped, chemically etched, formed from ceramics or metal deposited into most wireless devices, the Vortis provides a simple solution to several challenges facing the wireless industry.

Handset Maker's advantage:
1. Immediate, low cost, low impact solution to HAC for any handset without redesign.
2. Improvement in handset performance for all users.
3. Reduced SAR at full operating power.
4. Engineering resource support from highly qualified HAC Team.
5. Produced as a component and combined with rear plastic housing.
6. Advances Array technology (MIMO) for 3G applications.
7. Can be integrated in time to replace existing antenna.

The Carrier's advantage:
1. Immediate, low cost, low impact solution to HAC for any handset without redesign.
2. Unique, attractive, balanced antenna that can produce additional sales from performance and low SAR.
3. Offers a quasi diversity scheme for providing improved coverage and signal clarity.
4. Reduces defects from screw-in antennas.
5. Increased data transfer rates due to signal gain.
6. Marketable as a "High Performance" Handset that is HAC and Low SAR.

What this means to a mobile phone user:
1. Less RF interference from mobile phone handsets resulting in hearing aid compatibility.
2. Performance improvements such as distance, clarity, fewer dropped calls, battery usage and data transfer.
3. Unique new technology for reducing RF signal absorption by the head for safety, health and peace of mind.

What this means to a mobile phone maker:
1. FCC compliant with recent orders to make handsets compatible with hearing aids.
2. Greater market share from increased sales.
3. Technological advantage over competitive programs.

Antenna Operating Environment

A 1996 IEEE study pointed out that because portable handsets operate in close proximity to a human being, an important consideration involves the interaction of the radiated electromagnetic fields with the nearby biological tissue. This also holds true with the hearing aid. The computations revealed the human operator influence on antenna performance. The simulations presented for representative handset/tissue geometries revealed that the tissue exercises a noticeable effect on the antenna input impedance, radiation patterns, and gain for both external and internal configurations. The numerical simulations reveal that the "tissues absorb between 35% and 68% of the power delivered to the antenna for a head/handset separation of 2 cm."

This loss of signal has caused omni antennas to become directional antennas during operation. The far field propagation patterns when used next to the head are significantly distorted in gain and coverage. Considering these factors, antenna performance changes when tested in the intended operating environment.

1. Gain is reduced by as much as –1 to -3dB or more.
2. Efficiency is reduced to 25% or more.
3. Pattern coverage is reduced by as much as 20% or more.
4. Bandwidth changes due to parasitic coupling.

Given the rich scattering propagation environments of today's link budgets, these reduced properties and increased directionality are rarely noticed. However, in environments where optimum performance is an advantage or when comparing to less capable equipment, performance is a strong competitive edge.

The Vortis, with it's broad beam, high gain forward and rearward and deep nulls actually reduce head and hand coupling.

The Vortis as an Antenna Component or an Accessory

The present embodiments of the Vortis include single band and dual band models. Typically, the elements are positioned one on each side of a cellular telephone, so the plane containing equidistant points lies near the center of the handset.

The basic design has been structured to reduce design and redesign times when making changes or working over multiple form factors.

At economies of scale, the Vortis offers convenient manufacturing and cost advantages of adding virtually no substantial costs or real-estate requirements over existing antennas. When effectively integrated within an existing handset's plastic case, the Vortis offers specifications that can meet FCC and CTIA requirements.

Details of achievable specifications for specific form factors are available upon request.

Marketing Considerations of a Performance Antenna

With over 700 million handsets sold annually around the world and moving to over 1 billion by 2006, a 1% market share increase from new technology could mean over a half billion dollars in revenue globally for a handset maker or a billion dollars revenue for a US carrier. For this technology to launch through industry, cooperation between handset makers and carriers is required to bring embedded or accessory technology to market within industry channels. VTL is collaborating with carriers to promote this cooperation with handset makers and carriers.

In a recent visit to China, VTL learned that advertisements there tout performance and safety (health) aspects of one system over another. This could be the birth of open public advertising citing performance and safety as a competitive position. It is presumed that a growing number of users will become aware of these arguments (relevant or not) and will be driven to acquire a handset based on these issues. The growing awareness surrounding these concerns and the new technology marketing groups who are exploiting this could produce a shift in market share.

As an example, VTL met with The People's Republic of China's Director and the Deputy Director, Frequency Planning Division, Radio Regulatory Department of the Ministry of Information and demonstrated the Vortis. VTL also demonstrated the Vortis to the staff of the People's Republic of China Telecommunication Metrology Center of the Ministry of Information who are charted with certifying all handsets in China. The response was similar to most responses seen around the world: when people become aware of alternative methods of antenna propagation; the response is very positive with offers to assist in the dissemination of the Vortis technology.

VTL visited the Vice Director of Planning for a China Telecom company, who expressed interest in supporting the Vortis coming to market when handset makers bring the Vortis to fruition. VTL visited several handset makers in China who have expressed interests and are seeking ways to improve their handsets and expand in other markets.

The Vortis technology has attracted publications and news networks who support this new technology. These include: Hearing Review Magazine, Scientific American, Telephony Magazine Antenna Systems & Technology Magazine, NY Times, 5th Hearing International Science Conference; Peking University Beijing, China. Consumers write to VTL and express support and associates and suppliers all understand generally the impact of this new technology once released. The interests from industry promoters (see comments in the references section below) show promise in supporting the launch and dissemination of the Vortis technology because it is a unique and exciting.

Similar visits and surveys were executed throughout Europe, Eastern Europe and the U.S. with similar results; people get excited about the prospects of meeting HAC requirements and/or improving handset performance while reducing RF energy absorption by their head. The conclusion is that when end users are educated to the

performance aspects of the Vortis (through an effective marketing program), they draw their own conclusions and perceptions that drive sales and market share upward.

A New Wave of Arrays

The cell phone's antenna has always been a mechanical and electrical challenge controlled largely by fundamental physics of wavelengths. Given a proper plan, introducing the Vortis technology can improve several factors across a range of features and advance industry faster towards the ultimate goals. Improvements will come in the way of increased efficiencies, less power consumption, longer battery life, faster processing, clearer voice, less dropped calls and increased distance without increasing interference. In addition, the hearing aid compatibility and lower SAR makes the Vortis a unique solution for HAC while providing a foundation for new 4G antenna structures.

Most advanced R&D programs are focusing on concepts of "smart" or "steerable" antennas using Multiple Input, Multiple Output (MIMO) antennas. Ongoing requirements to integrate cellular and other signals such as GPS and streaming video as well as a need to create a means to transfer data faster between the handset and the system has created a re-design of the basic antenna infrastructures. The MIMO antenna structures are receiving a great deal of industry attention for 4G wireless communications. MIMO takes advantage of scattering in the propagation environment using multiple signals arriving at the cellular site with separate time/phase properties. MIMO has the capability to exploit these parallel signals by creating a stronger combined signal that reduces frame error rates and increases transfer speed. Driven by software and RF MEMS-based antenna-reconfiguration technologies, MIMO antennas can determine signal source and electrically point in the direction of the strongest signal. Because of a phenomenon called common mode caused by parasitic coupling between the two elements, array technology has not been readily achievable in the smaller form factors of handsets. This is due to the ratio of size to wavelengths and local interference within the handset. Cost, size, capability and other factors have prevented these arrays from coming to fruition without resolving this common mode. The Vortis design has stabilized this common mode condition using a proprietary design.

The minimum requirements for a MIMO structure are signal processing design changes in receivers and transmitters and new antenna technology requiring multiple antenna elements designed to exploit relatively uncorrelated propagation channels or to achieve directivity. This will take some time to implement and come to market. The Vortis is a transitional (partial MIMO) structure that meets today's needs for hearing aids while providing a front end structure for smart antennas later on.

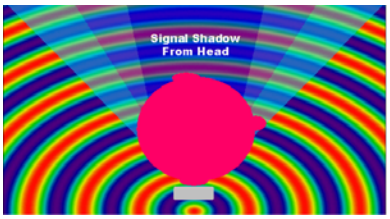
At the 2004 CTIA Conference in Atlanta, James R. Johnson, CEO/President of VTL and Steven L. Myers, PhD, CTO of VTL, presented the Vortis as a new and exciting array antenna technology. This IEEE Wireless Network Communication Conference demonstrated the Vortis' advantages in a working handset with the new antenna attached as an after market accessory. No special modifications were made to the handset. Relying on over 30 years of advanced practical experience in industry and military applications, Dr. Myers, an RF Antenna Designer created the Vortis as an immediate solution to regulatory requirements. VTL began optimizing the antenna to provide a cornerstone technology for next generation antennas in cellular handsets. Not limited by device type, operating technology generation and device features, the Vortis can be applied across the range of handset models and technologies without causing much design modifications to the handset itself. The Vortis will prove to be the first antenna of its kind to disrupt the industry as the paradigm changes from single element antennas to dual element arrays over the next few years. With experience in antenna design, manufacturing and quality assurance, Mr. Johnson and Dr. Myers formed Vortis Technologies Ltd. and are now seeking marketing support from industry partners to help launch the Vortis.

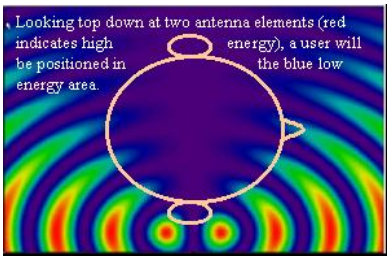
In a world of smaller, cheaper and faster, the cellular phone industry has been focusing on array technology as a basic requirement for increased gain and other advantages gained from reshaping the energy surrounding a handset. However, most technologists have been focusing on interactive steerable arrays and diversity antenna schemes that ultimately are designed to support 3G and 4G technologies in the future. These technologies are several years away and can be found only within the R&D functions of a few handset makers. The Vortis technology is an interim

technology available today with a window of opportunity reaching beyond 2007. At that time, 80% of all handsets in circulation will be feature phones and will likely have array technology built inside.

VTL worked to build consensus among several technology companies, government agencies, handset makers and carriers around the world. VTL sought to determine what, if any, effect this type of antenna would have with the public, industry, regulatory bodies and representatives. Early responses favored supporting the concept. Responses are noted in the reference section herein.

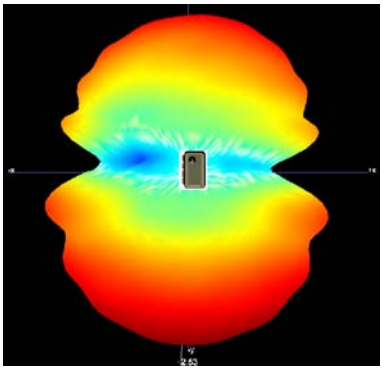
About the Vortis Technology





The Vortis is designed to offer a controlled, localized E and H field strength reduction for the purpose of minimizing radiated field interactions with hearing aids and the user's head and hand during normal use of a handset. In contrast to other widely utilized methods, the Vortis does not rely on delicate parasitic coupling of radiating elements for the control of RF energy. The Vortis's ability to exploit symmetry and destructive interference makes it an ideal solution to achieve an effective reduction of a cellular telephone's TDM On-Off Keying, audible with a hearing aid while maintaining compliance to HAC and SAR. The radiation wave pattern formed by the electromagnetic energy emitted from the radiating elements, absent the influence of large metal bodies (unperturbed, free space), includes a spatial null proximate to the antenna array and lateral to the two elements. The radiated energy emitted longitudinal to the array is constructively reinforced to produce gain in the far fields. The resulting figure-8 propagation wave pattern places the nulls in the direction of the user and behind the phone while the maxima are to the sides of the cellular telephone producing an idealized configuration. The Vortis is a passive, dual element, end-fire, interferometric array antenna operating at frequencies tested from 800 MHz to 1950 MHz with positive results. The antenna is currently produced as a printed element on a PCB and can be produced as a stamped part or metalized plating process over plastic.

In its current embodiment, two radiating elements arranged side-by-side separated by a distance less than one half of the wavelength formed of conducting material and adapted for use on a printed circuit board are embedded in the handset casing or attached to a handset's battery housing. These two elements emit two opposite polarity fields so that they annihilate each other in defined regions. Elsewhere, these fields contribute constructively to increase antenna performance. Phase shifting and power splitting are accomplished using a proprietary technique unique to the Vortis. Many RF engineers realize that to create this configuration is not trivial as is the case with many embedded antennas. The annihilating fields experienced by each element of the array complicate the design, together with the prevalence of common mode currents.



Looking from top down, this actual test in a 3D anechoic chamber was performed by Centurion Wireless Technologies Inc. This figure shows the energy around the handset. Blue areas are least energy; red are highest. Notice the "sweet spot" of silence (low energy) off the face of the handset.

The Vortis' unique design improves efficiencies and provides more power radiated toward the cell sites and can be integrated with most handsets for HAC and SAR requirements. Leading handset antenna engineers around the world understand the physics of interferometry and the difficulty in achieving a controlled, localized field strength reduction in the near fields of an antenna that is free of common mode. VTL has modeled the Vortis design for replicating to other wireless products. As many artisans understand, use of more advanced technology in smaller handsets is several years away for reasonable costs at less than $1.00. This leaves an opportunity for the Vortis to come to market. The Vortis operates by exploiting wave cancellation and enhancement techniques commonly found in electromagnetic theory. The Vortis shapes energy flowing near and around the handset and user by nullifying the RF energy toward the user's head and hand that is normally absorbed

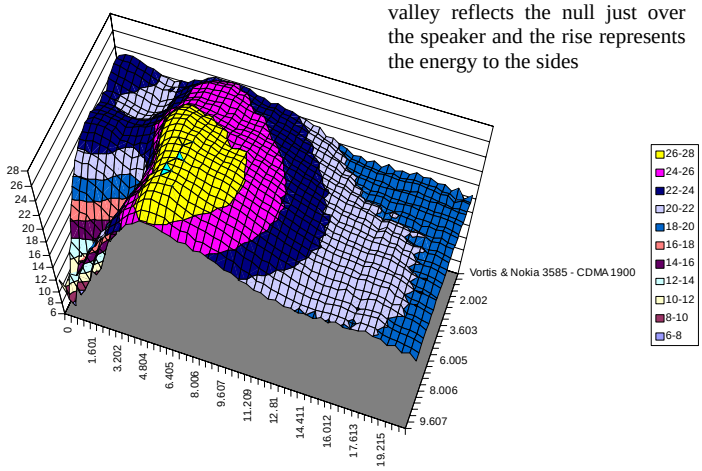
and enhances the RF energy outward where it is needed. This reduces wasted energy and improves overall efficiency, thus reducing power consumption resulting in increased battery life with potentially fewer dropped calls. The Vortis enhances energy forward and rearward of a user to improve signal coverage. More technical information about antennas and commercialization is available in VTL's white paper entitled "Passive Array Antenna for Next Generation Handsets" presented at the Cellular Telephone and Internet Association's IEEE Wireless Communication Network Conference in March of 2004.

The Vortis provides a quasi diversity scheme that provides immediate exploitable advantages in handset performance while supporting transitional processes leading into 4G technologies and Multiple Input Multiple Output (MIMO) implementations. The elements of the Vortis may be converted for use as individual radiating/receiving components of a phased MIMO front end as required for future applications and technologies.

Hearing Aid Compatibility Testing

As part of the initial development phase, VTL worked with hearing organizations and engineers to determine what, if any, impact the Vortis would have in supporting HAC requirements. VTL tested 47 hearing aids in collaboration with CSG Better Hearing Center in Walnut Creek, California, and with Stephen Berger, Chairperson, ANSI C63.19. The test results were significant and demonstrated that the Vortis has the ability to reduce RF interference substantially in non-T-Coil mode and, in most cases, completely as measured by listening to the device before and after the Vortis was applied. This opened the door for bringing HAC cellular phones to market. VTL presented its findings on behalf of the Federal Interagency Committee on Disability Research (ICDR) and its Technology Subcommittee workshop for "Interference with Hearing Technologies," on September 4, 2003, held at the Kellogg Center on the Gallaudet University campus, in Washington, DC.

This actual test diagram shows the field distributions at the left half face of the handset. The deep valley reflects the null just over the speaker and the rise represents the energy to the sides



Mr. Stephen Berger, the Co-chairperson to the ANSI C63.19 Standard for measuring compliance to HAC tested the Vortis near field capabilities. The testing standard adopted by the FCC for measuring HAC is the ANSI C63.19. This standard calls for a near field probe positioned 10 mm above the speaker of the handset and set for horizontal sweeps and measurements at every 2.0 mm. A profile of RF energy can then be obtained and a "user code" provided in accordance with the standard. This "user code" (referred to as U Code) provides a means to determine the handset compatibility with hearing aids. Handsets with a U code of 3 or 4 are considered very good because a level U4 provides a minimum of 15dB of RF reduction at this location. Each code is generally 5 dBs apart. Most handsets today fall within a U2 code. Handsets with low SAR generally will fall within the U3 code. RF interference sound can still be experienced even at the U4 code level but it is generally low enough to provide a conversation with the hearing aid user.

Mr. Berger conducted tests on several handsets in the market and found their power levels to be 75 to 150 V/m at the locations specified. Upon testing the Vortis it was discovered that this power is down to 8 V/m bringing the Vortis to well beyond U4 requirements. Opportunities to bring this value down further are built into the design process.

Carrier Compliance

The Vortis may be operated on any of air interface that cause the RF signal to transmit in digital packet data codes in order to maximize user capacity or security. It operates on cellular and PCS frequencies (Euro PCS 1710-1880 MHz, 1750-1870 MHz, and/or US1850-1990 MHz) with a typical bandwidth of around 25-50 MHz balanced for fields at prescribed nulls. The Cellular Telecommunications & Internet Association (CTIA) has developed testing protocols for testing to CDMAOne, CDMA2000, TDMA and AMPS within a CTIA Certification program through its designated CTIA-Approved Testing Laboratory (CATL). The CTIA's ERP Adhoc Group Testing Program and regime pointed out that there are currently no isotropic or energy pattern requirements since their testing addresses total effective radiated power output.

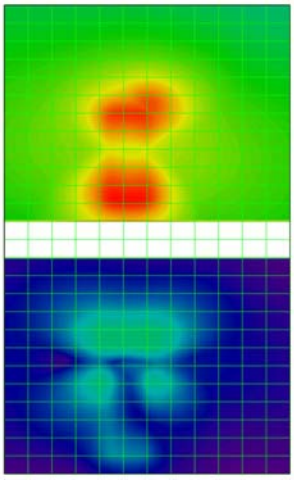
VTL has solicited and received general conceptual support from discussions with the CTIA, Cingular Wireless, Siemens, Self Help for Hard of Hearing People and other advisors for Cellular Standards and various other businesses and organizations in industry.

Although not tested to CTIA standards yet, peripheral testing for propagation patterns, efficiency, return loss and bandwidth shows that the Vortis is capable of meeting or exceeding the current CTIA standards.

Specific Absorption Rate Reductions

The non-ionizing radiation of surrounding RF fields for a cellular phone along with the conductivity and biological effects from ongoing use have been quantified within biological objects that are exposed to RF fields from cellular devices. The dosimetric quantity called specific absorption rate (SAR) was mandated in 1996 and the SAR values of handsets are posted to the packaging based on FCC compliance testing. SAR is determined by the incident of electromagnetic waves and by the electrical and geometric characteristics of the irradiated subject and nearby objects. SAR distributions are usually determined from measurements in human models or from calculations. Handset makers have implemented several strategies in order to meet regulatory requirements including repositioning the antenna location, using metalized or metal material between the antenna and the user, creating parasitic coupling to control field patterns when next to the head and reducing power output in order to bring SAR to required levels. Many of these strategies result in reducing the effective radiated power performance of the handset.

The simulations below reflect energy distributions at near fields from a typical brick handset. The grid is 1" increments and the two hot spots reflect the antenna and the ground plane



SAR, as a metric is reported as W/kg or mW/g and testing for SAR entails a well defined set of parameters using an average head and body model as well as a time exposure period. Several factors can effect SAR testing outcomes such as probes, phantom shape, liquid, liquid temperature, operating position, configuration of the handset and system performance. All operating modes are tested and tests are conducted on the center of the band with the output power set to maximum.

The scanned regions must be larger than the areas projected by the handset and the antenna with the distance measured at less than 8mm.

Current levels for the U.S. are 1.6 W/kg and 2.0 W/kg for Europe. China is likely to adopt the European standard for SAR but suggested conflicts between regulatory and industry desires.

The simulations above reflect energy distributions at near fields from a typical brick handset after the Vortis has been installed as an accessory. Notice that there has been considerable reduction in energy at the two hot spots and distributed more widely over two elements.

SAR improvements are readily obtained from a Vortis structure in two ways: 1) there is a natural reduction of half the energy due to the splitting of the output power causing an immediate reduction to SAR of approximately 3 dB. Additional reduction to SAR comes from the 180 degree phase relationship between the elements. The reduction is maximum near the plane of symmetry.

Regulatory Perspective:

Antenna technology and basic requirements have been developed under a basic isotropicity rule Part 24.232, 47CFR24.232 based on the assumption that a minimum isotropic standard was required to maintain adequate carrier connection.

On November 14, 2001 the commission was "Seeking Comments on whether public mobile service telephones should be required to be hearing aid compatible (HAC) in a NPRM pursuant to direction of the HAC Act. The Commission reexamined their exemption of public mobile service phones from the hearing aid compatibility requirements of that Act. Comments were due January 11, 2002, and replies were schedule for February 11, 2002. This was subsequently extended to July 10, 2003 when the Commission presented its report and order.

In developing the Vortis, VTL discovered concerns with CTIA and some carriers as to whether FCC regulations would allow for directional antennas since the effective isotropic radiated power (EIRP) call out in the regulations related to a spherical radiated pattern verses effective radiated power (ERP). Part 24.232(b) called for: (b) Mobile/portable stations are limited to 2 watts e.i.r.p. peak power (tolerance of +/- 2 dB) and the equipment must employ means to limit the power to the minimum necessary for successful communications. Since the isotropic call out seemed contrary to directional antennas, VTL sought a waiver to the isotropicity requirement found in regulations. This is further outlined in VTL's Position Paper dated 11/14/02 as presented to the FCC and explained further in VTL's response to Docket No. 01-309 comments NPRMWT filed on 5/15/02.

The FCC's public response was made in the NPRM on August 10th 2003 stating: (#47) "A directional antenna manufacturer, Myers Johnson, Inc. (VTL), has filed a petition for revision of this rule. VTL believes that the rule, as it is written, prohibits the use of directional antennas." The FCC says that "the EIRP requirement does not in any way prohibit employing wireless phone directional antennas." The FCC went on to state: (#46) "Because such antennas have the potential to significantly reduce the RF interference to hearing aids, as well as provide efficiency benefits both to the wireless network and to battery life, there are several benefits that could be gained from their increased use in handsets."

The FCC further stated within the order that "contrary to assertions [that directional antennas could cause systemic problems], directional antennas have the potential to help mitigate the effects of multipath, improve frequency bandwidth performance, achieve higher gain, and provide better directional control over emissions."

With reference to Hearing Aid Compatibility, there are three primary documents:

1. Hearing Aid Compatibility Act of 1988;
2. Section 68. 4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones
3. WT (Wireless Bureau) Docket No. 01-309, RM 8658 Notice of Proposed Rule Making

These three are cited as, HAC Act, FCC Part 68 and the NPRM. Additional regulatory issues are:

1. ANSI C63.19 Hearing Aid Compatibility standard for testing to the regulations.

2. 47CFR Part #24 Section, #232 Power and Antenna Height Limits, contolling antenna regulations.

3. CTIA's ERP Adhoc Test Plan and Handset Certification Program for testing to antenna requirements.

On November 13, 2002 VTL met with the Commission's Wireless Telecommunications Bureau's Senior Engineer Policy Division, Senior Economist, Policy Division and several other agents working on this matter.

VTL submitted three papers surrounding these issues designed to convice the Commission that the technology was readily achieveable and should be used in support of meeting requirements. These papers can be viewed on VTL's web page.

The Commission's reexamination of the exemption granted Personal Communications Services (PCS) devices from certain provisions of the HAC Act as announced in the NPRM, WT Docket 01-309 in July 10, 2003, was published in August 2003. The NPRM (2) require certain digital wireless phone models to provide reduced radio frequency (RF) interference (i.e., meet a "U3" rating under the ANSI standard). [ANSI C63.19 Technical Standard].

The petition submitted to the commission by VTL was not granted but the commission did clarify that the Vortis technology was not against regulations.

Technology, Business Purpose and Patent

VTL currently holds the following competitive position:

Sustainable competitive advantage:

1. **First to market with working models and expertise on array technology.**
2. **Two patents for passive phased array antenna.**
3. **Manufacturing agreement and strategic partnership with leading global antenna supplier.**
4. **Distributor agreements in place to provide customer service for hearing aid users.**
5. **Engineering & Management Group in place for executing sales and marketing program.**
6. **Advanced learning of interferometry can create scaleable solutions for most new and old handsets.**
7. **Antenna design and component costs can meet existing antennas and improve quality and performance.**
8. **Design and Manufacturing Program capability to produce low cost models for release within 90 days.**
9. **Form factor requires very little change to handsets and new look is attractive, unique and inspiring.**

About Vortis Technologies Ltd.

James R. Johnson (President/CEO) and Steven L. Myers, PhD (Chief Technical Officer) of Vortis Technologies Ltd. (VTL) developed the Vortis as a solution to the hearing aid compatibility problem in order to bring broader commercial application to this state-of-the-art array antenna technology. VTL is a private company founded in October 2001 in California under the name Myers Johnson Inc. with its corporate office in San Francisco. Resumes are posted to the web.

James R. Johnson is a 30 year veteran of Silicon Valley manufacturing with officer and director level experience for mid-size and small companies. His business experience includes start-ups, turn-arounds and has spoken throughout the country on improving manufacturing throughput, quality and profits using continuous improvement techniques. Mr. Johnson was also a Director of Quality Assurance for a new antenna company that developed internal antennas for cell phones.

Dr. Steven L. Myers, VTL's CTO, has 30 years of antenna design experience and is a leading supplier of advanced antennas for military, rescue, satellite and cellular systems. Dr. Myers is a leading expert in wave propagation theory and the concomitant design and application of antennas in both commercial and military environments. He is a licensed Professional Engineer, who received his Ph.D. in Electrical Engineering from the Florida Institute of Technology in 1992 with a doctoral dissertation focused on the "Electromagnetic Analysis of Guided-Wave Discontinuities".

A management team has been assembled that has international experience in antenna design, product launch, business development, international manufacturing, outsourcing, mechanical engineering and financial management. The team currently operates under various agreements to address requirements. Additional members are on standby pending launch of the business plan.

VTL intends on working with contract antenna suppliers and OEMs to bring the Vortis to market. The VTL business model will consist of a few key employees who support RF and mechanical design, manufacturing plans, program management, customer service and marketing. A support staff will execute business operations.

VTL's operations and organizational chart defines the organization's positions and requirements. The functions include management for operations and technology, sales and marketing staff, RF design engineers/technicians, mechanical designers/engineers, order fulfillment, customer service, and accounting staff. Many services will be outsourced on an as-needed contracted basis.

VTL's Financial Plan contains further details for review.

Rollout and Branding

Under the brand name, Vortis, the antenna will be launched in a four-phase marketing program designed to produce immediate revenue, build consumer support and develop a stronger marketing foundation for OEM adoption. The following sales and marketing plan will be executed:

Phase 1. **Hearing Aid User Accessory** (HAC). As an accessory antenna, the Vortis will be sold to a market share of audio hearing aid users who wear non-immune hearing aids in order to mitigate RF interference.

Phase 2. **Performance Antenna Accessory Market**: The same accessory developed for the hearing markets is expected to sell to existing cellular phone users seeking improved performance and less energy absorption by the head.

NOTE: Both of the above programs will require several models to address multiple handset configurations (VTL Product Roadmap).

Phase 3. **Antenna Component**. The Vortis will be sold to one or more mobile handset makers who see the Vortis as an improvement in performance and a unique competitive position.

Phase 4. **Vortis Technology Licenses.** The Vortis technology may be licensed to any supplier of antennas or RF technology as applicable. As the world adopts new array technology for 3G and 4G technology, many suppliers of antennas will seek opportunities to learn how to produce stable arrays for many consumer wireless applications. VTL has advanced learning in this area and will pass this learning on as appropriate.

The Vortis will be sold under several manufacturing and distribution agreements globally in order to supply all markets with either accessories or handsets with the Vortis inside.

Further details of this sales and marketing plan may be found in VTL's Sales & Marketing Plan #VTL PP HAC/PEA/OEM.

Business Model

As a "Next Generation Array Antenna for Improving Cellular Phones." This unique selling proposition will showcase the Vortis as an enhancement to cellular phone technology and an enabler of existing cellular phones for hearing aid users. Both of these conditions will provide handset makers with a unique market advantage if they choose to adopt early. As a transitional technology for the next generation of wireless technology, the Vortis will give early adopters a lead in moving to newer antenna technologies thus shortening the transition periods. By introducing the Vortis as an accessory today for the hearing impaired and for the performance enhancement market, VTL can realize immediate revenues and begin the branding process until the Vortis is introduced as an embedded model in newer handsets. VTL will wholesale the Vortis accessory with global distributors and marketing firms while providing engineering support directly with OEMs for new programs and component sales.

VTL is securing several sales, manufacturing and distribution agreements globally. VTL's structure will require engineering and program management focused on engineering projects, suppliers, manufacturing, distribution and sales. Under VTL's structure, it is not necessary to build a large labor-intensive organization in order to meet engineering, sales and marketing requirements. VTL will continue focusing its energy on developing next generation technology for phased array antennas. Intellectual property rights are expected to be an appreciable issue. Two leading law firms currently support VTL and plans are to allocate funds to address intellectual property rights and infringement issues directly.

VTL's operations and organizational chart defines the organization's positions and requirements. The functions include management for operations and technology, a sales & marketing staff, RF design engineers/technicians, mechanical designers/engineers, order fulfillment, customer service representatives, and accounting staff. Many services will be outsourced on an as-needed contracted basis.

Costing and pricing will follow an activity based accounting practice set by best costs (outsourcing) and NRE recovery. Distributor costs shall be a function of MSRP utilizing average profits with some extraordinary adjustments for exclusivity. VTL's Financial Plan contains a Manufacturing Costs Model for review.

Board of Directors

The technical advisory board and board of directors consist of technologists, wireless industry experts, financial experts and hearing industry experts.

Service Strategy & Acquisitions

A company such as VTL that has patented, launched and proven an advance technology is likely to be an up-stream or down-stream merger or acquisition candidate. It is likely that VTL will sell all or part of its interest to companies who wish to enter into the product/markets developed by VTL and further support VTL's customer's mission.

References & Comments by Industry Experts

NOTE: Some names have been removed for privacy or proprietary reasons. These names are on file for due diligence.

1. Dr. Steven L. Myers, developer of several advanced military programs for array antennas and developer of the Vortis: "The Vortis, as a full turnkey solution, offers the greatest balance between reduction of energy in the lateral regions, the greatest gain in the longitudinal regions and the widest bandwidth that can be tuned and produced as a single or multiband antenna component or accessory.

2. James R. Johnson, developer of the Vortis: "As either an embedded version or an aftermarket attachment, this antenna will be produced around the world to offer niche and global markets a means to improve the performance of their handset."

3. Name on file, former founder and VP of RangeStar International and Etenna Inc., two advanced antenna companies: "This is an example of Mores Law that will add value to the industry and the end user, glad to help your launch."

4. Stephen Berger, Chairperson to the ANSI C63.19 Standard for measuring compliance to HAC and Federal Regulatory Advisor and test authority who is testing the Vortis' near field capabilities and who worked for VTL on behalf of the FCC Petition: " When tuned to the handset, the Vortis offers a very good RF solution, that will likely exceed the standards." "The Vortis is a solution that goes beyond the HAC issue."

5. David Baquis, US Access Board Policy for consumer perspective, industry, research, Washington D.C.: "This is very good technology and meets Section 255 industry standard for "readily achievable solutions." "We must teach consumers of it's existance." VTL was invited to speak at the Interagency Committee on Disability Research (ICDR) and its Technology Subcommittee workshop for "Interference with Hearing Technologies," held at the Kellogg Center on the Gallaudet University campus, in Washington, DC.

6. Name on file; PhD, Sr. Systems Engineer for Cingular Wireless who assisted VTL in working with the FCC's regulatory issues: "A more directed antenna would naturally have higher gain and with the self-limiting features of the system, these antennas would add value to the user."

7. Name on file CTO for Centurion Wireless Technologies, one of the largest antenna companies in the world and now a strategic manufacturing partner of VTL. CWT performed several of the validation tests necessary to ensure an antenna of this type will work across all technical barriers: "The Vortis is a viable solution that can come to market now. We can deliver anywhere in the world to OEMs or build millions of accessories as the case may be."

8. Brenda Battat, Director of Public Policy: "SHHH sent a letter to the FCC supporting Myers Johnson Inc's (VTL) petition to revise an FCC rule to allow the use of directional antennas with wireless phones. VTL the company that developed directional antennas for use in wireless phones, has shown that they reduce the RF interference caused to hearing aids and cochlear implants." "They will make a significant difference for people with hearing aids that do not have immunity to RF interference. Today directional antennas are accessory add-ons but in the long-term, they can be designed into the handset."

9. Name on file, a business development engineer in Cambridge, England, involved in a number of projects in existing and emerging technologies such as WiFi, Ultrawideband Radio, Smart Antennas, Bluetooth, GPRS and UMTS and who supported Antenova Ltd (a VC funded technology company developing innovative ceramic and array antenna technology). This engineer did a due dilligence report on array technology: "This product would do well in the UK and EU and we are ready to assist."

10. Name on file, Sr. RF Tests Engineer, Centurion Wireless Technologies: "The total effective power effeciency is very good, the SAR is the lowest we have seen and the concept is sound. I would recommend this to industry and would use it myself."

11. Dr. Vichate Ungvichian, P.E., Director of Florida Atlantic University / Electromagnetics Interference Lab: "The results we found in testing this antenna were quite interesting. We have been working in this area of directional antennas." "We found reductions of energy in the near fields in the level of 19.7 dB maximum differential at 1 data point per degree."

12. Om Gandhi, Department of Electrical & Computing Engineering, University of Utah, author IEEE's Electromagnetic Fields, Human Safety Issues and Electromagnetic Absorption In the Human Head and Neck for Mobile Telephones at 835 MHz and 1900 Mhz Frequencies. A well recognized expert in this area doing work both with computational analysis and direct measurements: "Because of the near field coupling, all of the power going toward the head and hand doesn't come out and is lost. This can be mitigated by array technology if you have a reduction of energy in the right place. How effective are they depends on the right combination of antenna designs. I think it's the proper way."

13. Name on file, Account Executive, Major Carrier U.S.A. "I have a number of very large corporations with employees looking for this type of solution. I was actually forwarded your website by a woman looking to use your services."

14. Patrick Forster, Senior Engineer Policy Division, Wireless Telecommunications Bureau, Federal Communications Commission, Joseph Levin, Senior Economist, Policy Division, Wireless Telecommunications Bureau and several others:

"We do not feel the [antenna] rules as written prohibited directional antenna." Also, Tom Stanley, FCC Wireless Bureau provided recommendations for VTL's efforts with the FCC regulations. Ultimately, the FCC ruled in favor of the Vortis concept citing: "Directional antennas have the potential to improve signal performance and battery usage while mitigating the RF interference experienced by hearing aid users." VTL positioned as a leading innovative antenna developer.

15. Name on file, People's Republic of China's Director and the Deputy Director, Frequency Planning Division, Radio Regulatory Department of the Ministry of Information: "This is a very good thing to know since we would like to have lower SAR standards but were unaware of this technology. Please come to our industry conference next week for additional assistance from our industrial associates."

16. Name on file, People's Republic of China's Telecommunication Metrology Center of the Ministry of Information: "We certify all handsets that are sold in China. We would like to introduce this to our technical resources."

17. Name on file, Vice Director of Planning for a very large Chinese Mobile Telecom Corp (on file): "With our channels, we can help you implement this in China. We can provide assistances and local manufacturing plants."

18. Several OEM's have expressed interests and VTL has NDA agreements in place and are moving forward carefully. "For the Vortis to be incorporated, we will need to complete our testing and make recommendations to the PSC Mfg. Groups."

Conclusion

Cellular phones will all have array technology in them in 5 to 10 years. This is inevitable. The Vortis is available now and can take a leadership role in the development of the antenna front end structure with it's patented approach to removing the technical problem of common mode while producing deep nulls toward the head and improved performance due to the patterns and gains in the far fields.

With the average mobile phone user spending 6,000 minutes per year on a cell phone and younger users reaching 21,000 minutes or more there is a real opportunity to provide these users with increased performance and reduced RF energy loss to the head. This will translate to additional revenue for carriers and for handset makers who adopt the Vortis will support increased sales. The global user base is over a billion now and will climb to over two billion in five years giving an opportunity to meet projected numbers once the channels have adopted this technology. Annual handset sales are now over 700 million units as new users move to new features and handsets offer more advantages.

With voice, Internet, integrated digital cameras, video, music, polyphonic ringtones and games as a means to improve competitive positions in this feature rich environment, the Vortis will be an added support for these features as well. It is clear that this user base will grow in education and begin demanding more performance over features. VTL and the Vortis has a sustainable competitive advantage over all other means of controlling RF signals around a cell phone while meeting compliance and cost requirements.