



Docket No. 03-122

## ***Introduction***

The purpose of this document is to provide a background history of Arcwave Inc., and explain the ramifications that FCC ET Docket No. 03-122 and FCC NPRM RM-10371 will have on the company and its customers. Specifically this response is in regards to the dynamic frequency selection (DFS) requirement in the proposed new rules for U-NII operation at 5.250-5.350 and 5.470-5.725 GHz.

## ***Arcwave History***

Arcwave Incorporated currently has fewer than 100 employees, and is classified as a “small business entity” under section (3) of the US Small Business Act.

Arcwave Inc. was created from the merger of Advanced Radio Cells Inc. (ARCI) and CoWave Networks in May 2003. ARCI was originally incorporated in 1999, with a stated purpose to develop new and innovative wireless products and systems based on the emerging DOCSIS<sup>1</sup> broadband protocol. CoWave was incorporated in 2000, and has developed a leading future mesh communications architecture, MeshCast, which is currently under consideration with IEEE 802.16 to be the mesh standard for wireless metropolitan networks.

Arcwave’s target customers are primarily ISPs and regional telcos providing wireless Internet service to underserved broadband markets. A growing number of new broadband wireless operators have overwhelmingly adopted license free radio spectrum as their chosen method to offer service. MMDS and LMDS system operators have contrastingly failed to provide cost effective broadband wireless services. Arcwave has established customer acceptance with its DOCSIS based 5 GHz U-NII band point-to-multipoint broadband wireless system. Arcwave is currently providing ISPs and Telcos throughout the U.S. with high capacity wireless broadband delivery systems, meeting the required performance and costs for profitable broadband wireless service to under-served communities.

Arcwave has survived through historically one of the worst environments for the telecommunications industry, and broadband wireless companies in particular. In part this is due to the merits and customer acceptance of Arcwave products and technology. Historically by virtue of its strategy of adapting DOCSIS for wireless rather than inventing completely new MAC layers and new protocols, Arcwave has effectively concentrated its engineering skills in radio hardware development and wireless system design.

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<sup>1</sup> Data over Cable Service Interface Specification is the cable industry’s standard for broadband cable modems. Virtually all contemporary CATV systems delivering two-way broadband data utilize DOCSIS.

## ***Market Positioning***

DSL and cable broadband data services are available to only half of North America, leaving 24 million households and businesses without broadband. AT&T, Sprint and WorldCom broadband wireless systems addressed this need, but targeted the top 25 US metro areas, where DSL and cable already dominate. Spending millions to buy market share was a failed strategy. Arcwave instead has focused on sales to regional ISPs and telco's in under-served mid to small sized communities where landline solutions are costly to build out.

Traditionally wireless ISPs had to choose from deploying either WLAN based systems (limited network capacity, 2.4 GHz band interference, and questionable security), or deploying complex proprietary systems. Because of the high cost of almost all non-standards based systems, a large and growing number of ISPs have chosen 802.11 WLANs, but have implemented the systems using illegal power and non-compliant antennas in an ever spiraling effort to overcome growing interference.

Arcwave uniquely offers a DOCSIS based alternative, providing a cost effective solution to ISPs and telcos bringing broadband connectivity to the market.

## ***About DOCSIS***

DOCSIS was developed in the late 1990s through the creation of the joint industry consortium Cable Television Laboratories Inc. (Cable Labs). It is a widely adopted standard for bringing multiple access TCP/IP Internet delivery to subscribers over cable television networks, and DOCSIS has become the leading broadband standard in the world. In the United States there are more DOCSIS subscribers than all other broadband (DSL, fiber, satellite, etc.) combined.

Chip sets for both the headend processing and the subscriber modem products are available from multiple vendors including Broadcom, Conexant, and Texas Instruments. Over twenty manufacturers including consumer electronics staples such as Motorola, Toshiba, Phillips and Sony are currently producing DOCSIS standard cable modems and many more are on the way. The DOCSIS specification [1] defines the baseband and radio-frequency physical (PHY) layer, and the media access control (MAC) layer, interface for DOCSIS based systems.

The DOCSIS standard itself contains several features to assist with mitigation of noise and interference, which perform equally well in a properly configured wireless system. The cable modem is capable of automatically scanning a range of downstream frequency channels, finding the proper signal, and synchronizing to the data. This is useful when operating in a license free band where other signals may be present. Both the downstream and the upstream signals employ

adaptive equalization, which is optimized for each individual user. Although designed to combat the multipath signal reflection interference present on a cable system, the DOCSIS adaptive equalization works equally well in a properly tuned wireless system. The DOCSIS upstream modulation is designed to combat the noise and interference ingress typically present in the low frequency portion of a coaxial cable network. The DOCSIS hub controls the frequency, data rate, timing, equalization, and output power of each subscriber. This capability provides robustness to the upstream in a wireless system. Both downstream and upstream signals employ forward error correction (FEC) to enable a low bit error rate (BER). Along with these attributes, a wireless system can build additional technology such as smart antennas, repeaters, and micro-cell architecture on top of the DOCSIS PHY layer.

Although originally designed for a cable television system, DOCSIS-based protocols were first employed in wireless systems by MMDS “wireless cable” system operators. Taking advantage of the standard 6 MHz television channels used by both systems, the DOCSIS modem and the cable hub work together with a radio system to place the upstream and downstream channels in the MMDS microwave frequency bands. Additionally if the wireless antennas are sectored, frequencies can be reused thus greatly increasing the effective bandwidth (and subscriber capability) in a wireless DOCSIS system.

### ***Arcwave Technology***

An ideal frequency band for wireless DOCSIS is the 5 GHz license free national information infrastructure (U-NII) band, which was intended for wireless Internet access, away from the clutter and congestion of the 2.4 GHz ISM band used for consumer electronics devices such as cordless phones and microwave ovens.

The Arcwave technology contains an innovative architecture to enable full duplex operation simultaneously using the 5.3 GHz U-NII band for upstream data transmission from the subscriber premises to the hub, and 5.8 GHz for downstream transmission from the hub to the subscriber. All upstream transmission is power controlled by the DOCSIS hub (CMTS) controller, to maintain minimum necessary power to be transmitted. Maximum EIRP limits are also maintained automatically in the system. Channel assignments at 5 GHz are set by the system operator, mapping DOCSIS IF frequencies into the respective upstream and downstream 5 GHz bands.

## ***Arcwave Products***

The Arcwave “ARCell” system is a turn-key broadband wireless solution based on its own CPE and hub radio components, and utilizing cable modems and DOCSIS hub system components from partner vendors. These DOCSIS components have added physical layer firmware enhancements (primarily for modulation), which enables improved wireless performance. Leveraging the associated volume cost curve, as well as emerging DOCSIS network and customer applications, this system provides an unparalleled cost performance value for medium sized ISPs and regional telephone operators.

The Arcwave “ArcXtend” system builds on the success and experience Arcwave has achieved in the ISP markets, and is contrastingly targeted directly to cable system operators to extend their DOCSIS coverage area using wireless. Unlike the ARCell system, ArcXtend does not require a change in the DOCSIS CMTS or modem firmware, and is designed to use the standard DOCSIS cable modem and CMTS components existing in the cable system. Consequently, the range of ArcXtend is about 1-2 miles, primarily due to the requirement to operate with 64 QAM modulation, but this is well within the requirements for cable extension.

Major cable system operators, along with the Cable Labs organization, have endorsed the ArcXtend system, and both have been assisting Arcwave to develop this product to meet their emerging need to offer wireless system expansion. Arcwave is in a unique position to offer the cable industry a system which can cost effectively maintain the DOCSIS physical layer throughout wireless transmission, enabling the effective management of the wireless segments through all of their existing network layers and protocol.

The strategic direction of adapting DOCSIS, the predominant broadband standard in the world, for use in license free wireless frequency spectrum, has presented Arcwave with several key business opportunities presently. Arcwave is committed to provide the marketplace with high performance, yet affordable, standards based broadband wireless systems.

## ***Intellectual Property***

Arcwave has four patent applications filed related to its DOCSIS product line, the first of these having been granted by the U.S. Patent Office. These patents cover various aspects of adapting DOCSIS for broadband wireless communications. The patent granted covers specific design methods of using a DOCSIS cable modem upstream over a license free wireless transmission. Other areas of the patents filed include DOCSIS based wireless repeater technology, flat panel antenna design, and DOCSIS cable system expansion using wireless DOCSIS.

## ***FCC 03-122 Ramifications to Arcwave***

Arcwave would like to commend the FCC for the speed with which they acted to bring new spectrum available for expanding the U-NII bands to meet the growing market need for license free spectrum. With respect to other than DFS, the current Arcwave products using 5.250-5.350 GHz and future planned 5.470-5.570 GHz upstream transmission would be compliant with the proposed rules.

For both 5.250-5.350 GHz and 5.470-5.725 GHz, the DFS proposal would render unusable any system based on the DOCSIS protocol. The key limiting factor for a DOCSIS based system is that there is no mechanism to allow DFS to change the upstream frequency. This is because control of DOCSIS upstream channel assignments is set at the DOCSIS system headend location, and upstream assignments once programmed remain under the control of the DOCSIS protocol. Although DOCSIS does have a limited feature to hop upstream frequencies based on interference received at the head end, this can not be used in a wireless system because there would be no synchronization with the wireless portion of the system. This is because the baseband CMTS processor has only a RF signal connection to the wireless radios. In fact any attempt by a radio to dynamically change the DOCSIS upstream channel assignments would materially interfere with the overall operation of the DOCSIS protocol.

For the ArcXtend product which operates in a cable data network, one cable upstream channel is typically set aside for wireless use. The channel assignment originates at the cable headend, where the CMTS transmits a command on the downstream channel addressed to the wireless based subscribers, which sets a modem output frequency. This frequency directly maps to a wireless upstream channel in the 5.3 or 5.5 GHz band. This channel is then received at the wireless hub, which has already been preprogrammed to receive this wireless channel. The channel is then downconverted to the same modem upstream frequency originally transmitted by the subscriber modem, and injected back into the cable system upstream.

Tampering with the upstream synchronization of DOCSIS would disrupt normal cable system operations, and thus make the Arcwave technology unfeasible for cable operators to employ. There is also no mechanism to use wireless RSSI information to change upstream channels since there is no control communications between the wireless hub and the cable CMTS, and secondly there is no method to seamlessly change the DOCSIS frequency assignments.

Arcwave field engineers have seen little evidence of radar systems interfering with 5.3 GHz systems at its various customer sites. The burden of operating with interference is placed on the system operator, and in an Arcwave installation they manually place the upstream channel assignments on clear frequencies within the 5.3 GHz or the future 5.5 GHz band. It is unlikely after establishing an upstream channel on a clear channel, that any CPE transmissions within the Arcwave 5 mile system operating radius would have a field strength which could interfere with distant radars not previously visible at the hub location.

## Summary

The technical experience and background of Arcwave and its engineers is based on radio system development, and to undertake a major revision of the DOCSIS protocol is beyond the ability and resources of the company. Even if the company could produce a modified version of DOCSIS, any Arcwave modification to the DOCSIS protocol would not be accepted by the marketplace, and would in fact be totally unacceptable by the cable industry since they are committed to using only products which are completely DOCSIS compatible.

The DFS feature requirement could have an extremely negative impact on the future for Arcwave. Indeed the company's ability to effectively sell to customers and to raise additional financing may be affected if Arcwave were no longer able to leverage its wireless DOCSIS technology, and to sell its DOCSIS compatible products to the marketplace.

In Arcwave's opinion there are a multitude of technical and market benefits which emanate from employing DOCSIS, which has become the worlds leading broadband protocol, for high speed wireless networks. These advantages far outweigh the indeterminate benefit of having a DFS feature. For Arcwave's products which are based on the DOCSIS protocol, there is no effective work-around to enable DFS to operate effectively within DOCSIS.

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