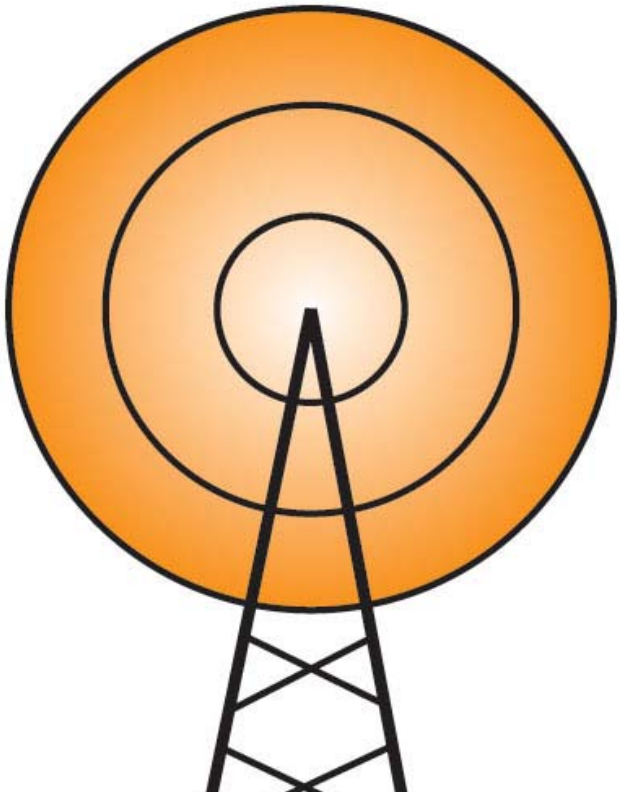
ARRIS

System Description



3.5 GHz BROADBAND WIRELESS

October 2004

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1 Executive Summary

ARRIS is pleased to present you with this summary description of a typical Broadband Wireless Access network solution based on proven Data over Cable Service Interface Specifications (DOCSIS®) technology.

Our network solution proposal marries DOCSIS® to our Cable Modem Termination Systems (CMTS) with ARRIS radio frequency (RF) technology. Commercial deployments have demonstrated that the CMTS approach achieves high performance and reliability in a cost-effective fashion.

ARRIS designs and supplies leading-edge broadband access transmission equipment, primarily for broadband fixed wireless networks and data over cable. Service providers use ARRIS's products to deliver high-speed data, Internet, video on demand (VOD), Voice over IP (VoIP), and other bandwidth-intensive services to residential and business subscribers. ARRIS's products are designed to allow service providers to rapidly and cost-effectively bridge the last mile, by overcoming the bottleneck resulting from insufficient bandwidth existing in legacy last mile infrastructures. The Company's customer base includes original equipment manufacturers (OEM), system integrators, and leading multiple system operators (MSO) and other service providers. Please find details at http://www.arrisi.com/.

The key feature of ARRIS's solution is that high volumes of standard DOCSIS® modems are being produced by a large number of manufacturers; the economies of scale thus created result in inexpensive, feature-rich subscriber equipment.

The basic, most cost-effective network is designed with only a limited amount of redundancy. Options are available that provide full 1-to-1 redundancy for all CMTS and base station RF equipment.

2 System Overview

The architecture of the system uses standard DOCSIS® cable equipment as the network elements. Complementing this standard DOCSIS® setup is ARRIS-sourced RF hardware designed to translate specific sub-bands of the DOCSIS® cable frequency plan into the frequency allocations of each specific customer.

Key characteristics of the system are:

- 27 Mbps time division multiplexed downstream using 64QAM in a 6 MHz channel

- 256 Kbps to 10 Mbps time division multiple access burst per upstream using QPSK, QAM8 or QAM16 modulations

- near line of sight performance at many frequencies
- systems already operating at 700 MHz, 1.9 GHz, 2.1 GHz, 2.3 GHz, 2.5 GHz , 3.5 GHz and 5.8 GHz
- audible installation alignment beeper available on some models to facilitate customer self-install and avoid a truck roll
- economies of scale by reusing existing DOCSIS® products which are now being deployed in high volume worldwide

2.1 DOCSIS® Overview

DOCSIS® is an open industry standard developed and coordinated through the efforts of cable MSOs and technology manufacturers such as ARRIS. Under the watch of the non-profit institution CableLabs®, DOCSIS® technology is mature and in operation in many countries around the world as the standard for Internet access on hybrid fiber coax cable systems. A fundamental advantage of using DOCSIS® is the wide variety of manufacturers producing cable modems and the volumes currently being deployed which translate into very cost-effective subscriber equipment. Over 15 million DOCSIS® cable modems are currently deployed worldwide with over 200,000 upstream DOCSIS® ports.

DOCSIS® wireless-based cable modem pricing is now less than US$65 when purchased in quantity.

The technology behind DOCSIS® also lends itself very well to use as a fixed broadband wireless access mechanism. A well-developed physical layer, sophisticated media access control, and a complete network reference model provide for a commercial grade wireless system.

A quick overview of features is given below, but a more thorough discussion on the specific technical requirements for wireless can be provided as your project matures. The CableLabs® website, http://www.cablemodem.com/ also contains the current DOCSIS® specifications.

2.1.1 Physical Layer Characteristics

Key parameters of the physical layer include:

Downstream:

- 30 Mbps in a 6 MHz RF channel (standard DOCSIS®)
- 64QAM, 16 QAM, and QPSK modulations
- Reed-Solomon forward error correction (~10% overhead)

- continuous transmission

Upstream:

- variable channel bandwidths from 200 KHz to 6.4 MHz
- QPSK, 8QAM, and 16QAM modulations
- Reed-Solomon forward error correction (~10% overhead)
- burst mode transmission
- error correction
- signal precompensation
- adaptive power control over 50 dB range
- encryption

2.1.2 Media Access Control (MAC)

The DOCSIS® MAC uses a request/grant mechanism under central management of the CMTS. This time division multiple access (TDMA) reservation-based protocol requires each CPE to request a time to transmit data. The CMTS examines all of the incoming requests and grants a time to transmit based on a multitude of parameters including CPE data rate limitations and service priorities. A DOCSIS® compliant system with full QoS features is standard.

2.1.3 Security

Baseline Privacy Plus (BPI+), included as part of the DOCSIS® protocol, provides advanced security and privacy features for both the service provider and the customer. All over-the-air communications operate with 56-bit DES encryption (or 40-bit where regulations require).

Additionally, encrypted key management between the CMTS and modems requires subscriber authorization and registration to ensure reliable and secure billing for multiple server classes, which prevents unauthorized access to the system. Cable modems can support end-to-end 3DES encryption.

2.2 Point to Multipoint Configuration

Figure 1 shows the overall system diagram for point to multipoint communication. A generic diagram of a supercell configuration is used. In this drawing, a single downstream and upstream antenna is shown. Many combinations of antennas and sectorization can be deployed.

A generic diagram of a single sector system is shown but standard configurations allow for one, three, four and six sector base stations. Detailed network capacity and RF planning is necessary to determine the optimum solution for a specific customer requirement.

Since the amount of spectrum available in the 3.5 GHz band is highly dependent on the country of operation, a standard band plan is not appropriate. ARRIS can support the following generic channel plans as per CEPT ERC 14-03 and 12-08:

3400-3700 MHz 24 MHz subbands, 50 or 100 MHz T-R spacing

Detailed network capacity and RF planning is necessary to determine the optimum solution for a specific customer requirement. Custom spacing and subbands for specific customer and country frequency allocations can be developed as required.

FIGURE 1 - POINT TO MULTIPOINT SYSTEM OVERVIEW

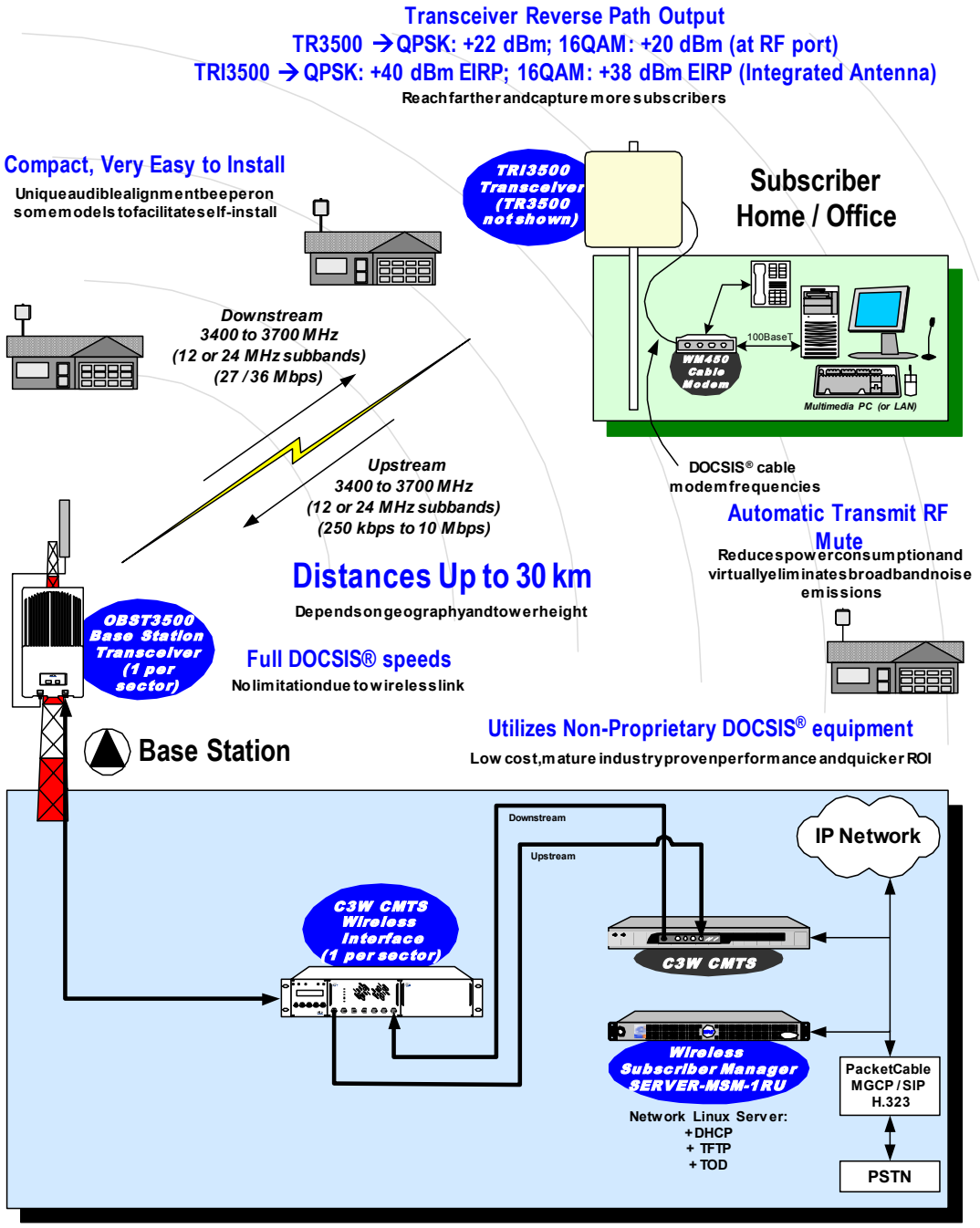

Figure 1: Point-to-Multipoint Overview

2.2.1 Base Station

Figure 2 shows a detailed diagram of the standard base station configuration; the transport/network connection ties directly into the hub CMTS. This capability at 3.5 GHz

requires two additional ARRIS-supplied components to complement the CMTS at the base station (hub) site. These additional components serve to convert the standard DOCSIS® cable frequency plan to the required 3.5 GHz frequency plan and include the following:

- WM4040 CMTS Wireless Interface (Indoor Unit)
- ODUBST3500 Base Station Transceiver (Outdoor Unit)

For maximum integration and simplicity of interface at the base station, a common, universal indoor module for all single-carrier-per-base station transceiver systems from 2.1 GHz to 38 GHz was developed. This common module, the WM4040 CMTS Wireless Interface, connects to both the CMTS and the ODUBST3500 Base Station Transceiver. The WM4040 provides for sophisticated management of the ODUBST3500 frequency plan and power levels. It also provides alarm indications on the performance of the IF up-converter and base station transceiver.

This WM4040 module provides the following interfaces:

Network Element	Interfaces
CMTS	Upstream IF at 17-42 MHz (up to 6 upstream channels per module on 6 separate female 'F' connectors) Downstream IF at 44 MHz (single channel per module on female 'F' connector)
NMS	SNMP over 10BaseT Ethernet (on female RJ45 connector)
ODU (single coaxial cable)	Downstream IF in the 88-858 MHz band Upstream IF at 17-42 MHz Bidirectional signaling for BST management Frequency reference DC supply voltage (all delivered on single coaxial connector)
Other	Front panel display and controls AC (100-240VAC) or DC (-48VDC) power supply connection Up-converted IF Monitor port

An internal splitter is used to separate the single upstream connection from the outdoor transceiver into six separate 17 MHz to 42 MHz upstream IF signals. All connections to the outdoor transceiver, including DC power, are made through a single coaxial cable for ease of installation.

The software module to support the frequency plan is factory-loaded into the WM4040. This ensures that the output frequency is properly configured to prevent accidental emissions outside of the regulated band. Additionally, these software changes ensure that the front panel and management interface display accurately reflect the RF over-the-air frequency plan rather than the IF signal carried between WM4040 up-converter and transceiver. All software upgrades to the WM4040 can be initiated without disruption of service to that sector. Any WM4040 module can control any frequency transceiver when loaded with the appropriate software drivers and security is included in the transceiver to ensure that the WM4040 frequency settings accurately reflect the transceiver frequency plans and duplexers installed. Updated software modules can be loaded at any time via TFTP.

Management of base station transceivers is performed using a bi-directional, half-duplex signaling protocol. Full control of transceiver operating parameters is provided via the standard element methods: front panel buttons and display, or RS232. Full control of transceiver operating parameters using an SNMP interface is optional. Transceiver software upgrades can also be initiated through TFTP.

Output power management is done under control of the NMS. The WM4040 and transmitter combination implement two power control modes: closed loop automatic transmit power control and open loop gain control. Closed loop automatic transmit power control (ATPC) attempt to set the measured output power to the value specified through the management interface. In open loop gain control mode, a specific gain is set for the WM4040/transmitter combination and output power level tracks input power level, but is hard-limited to never rise above a level that could exceed the spectral mask.

Redundancy within the WM4040 is optional. This redundancy allows a redundant power supply and upconverter card to be included in the chassis. The secondary path connects directly to a secondary CMTS modem.

The ODUBST3500 Base Station Transceiver is an outdoor transceiver mounted next to the antenna. Various external single antenna configurations depending on the cell size and subscriber density are available; standard options include omnidirectional, 120º, 90º, and 60º.

The WM4040 is used to communicate with the BST3500 to accomplish functions such as setting transmit frequency and power level and polls the BST3500 for indication of system performance and alarm conditions.

FIGURE 2 - POINT TO MULTIPOINT BASE STATION DETAIL
Single Sector

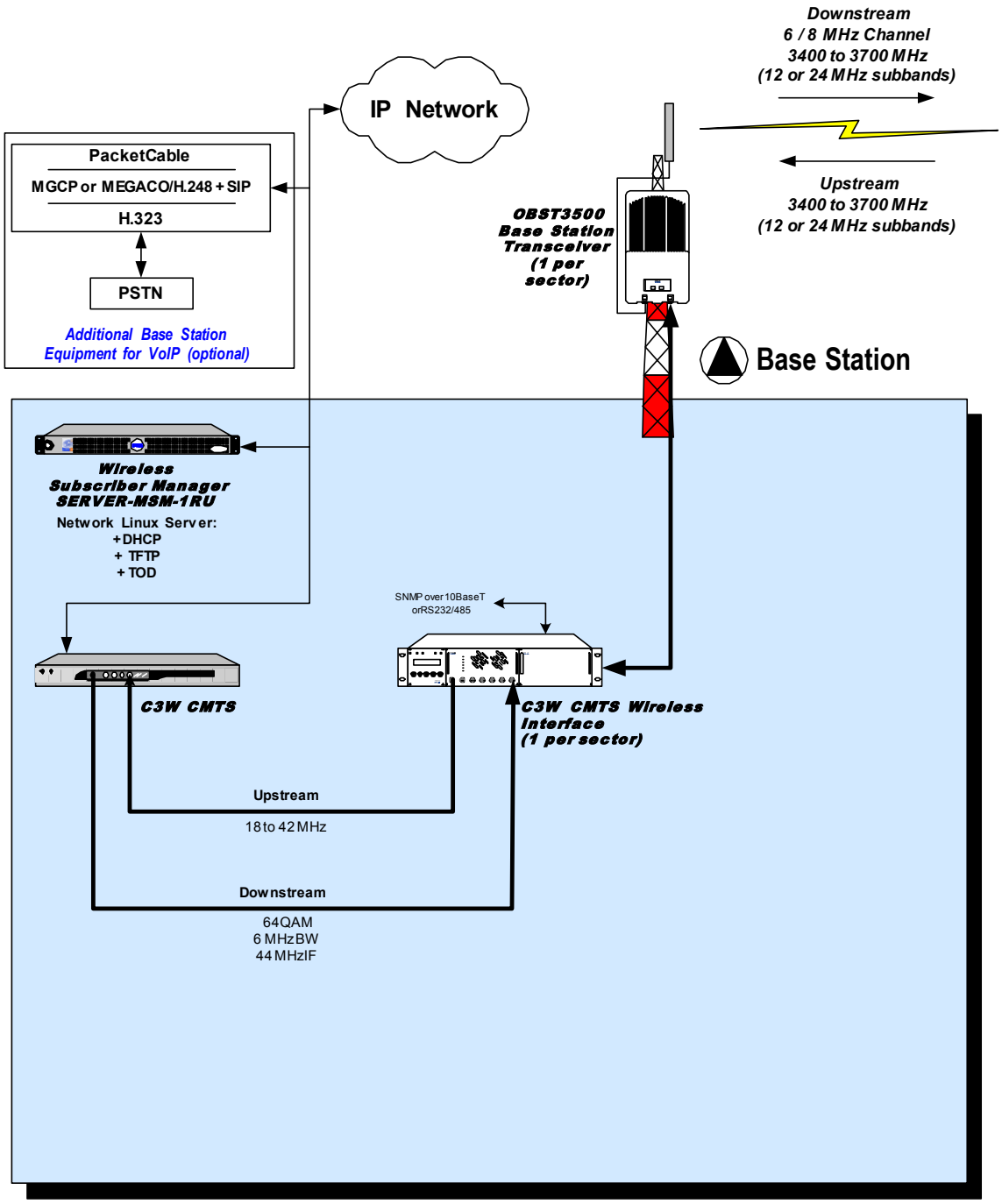

Figure 2: Point-to-Multipoint Base Station Detail

2.2.2 Subscriber

Figure 3 details the configuration for a standard subscriber installation. There are two fundamental elements, each with multiple options depending on performance and feature set: the outdoor RF transceiver (TRI3500) and the indoor DOCSIS® WM450 modem.

The TRi3500 Integrated Subscriber Transceiver serves to translate frequencies and amplify the upstream and downstream signals to the appropriate cable frequencies for use by the indoor DOCSIS® modem. A highly directional flat panel antenna is integrated with the transceiver, and a single low-cost 75 ohm cable (that is, RG-59 or RG-6) is used to connect between the transceiver IF port and indoor AC/DC power inserter. A short jumper cable is used to connect to the DOCSIS® modem. ARRIS also has transceiver options for inband operation from 2.5 to 2.7 GHz.

If voice service (VoIP) is also desired, the ARRIS WM402A voice and data unit can be substituted for the WM450 modem.

FIGURE 3 - POINT TO MULTIPOINT SUBSCRIBER DETAIL
Subscriber Home/Office

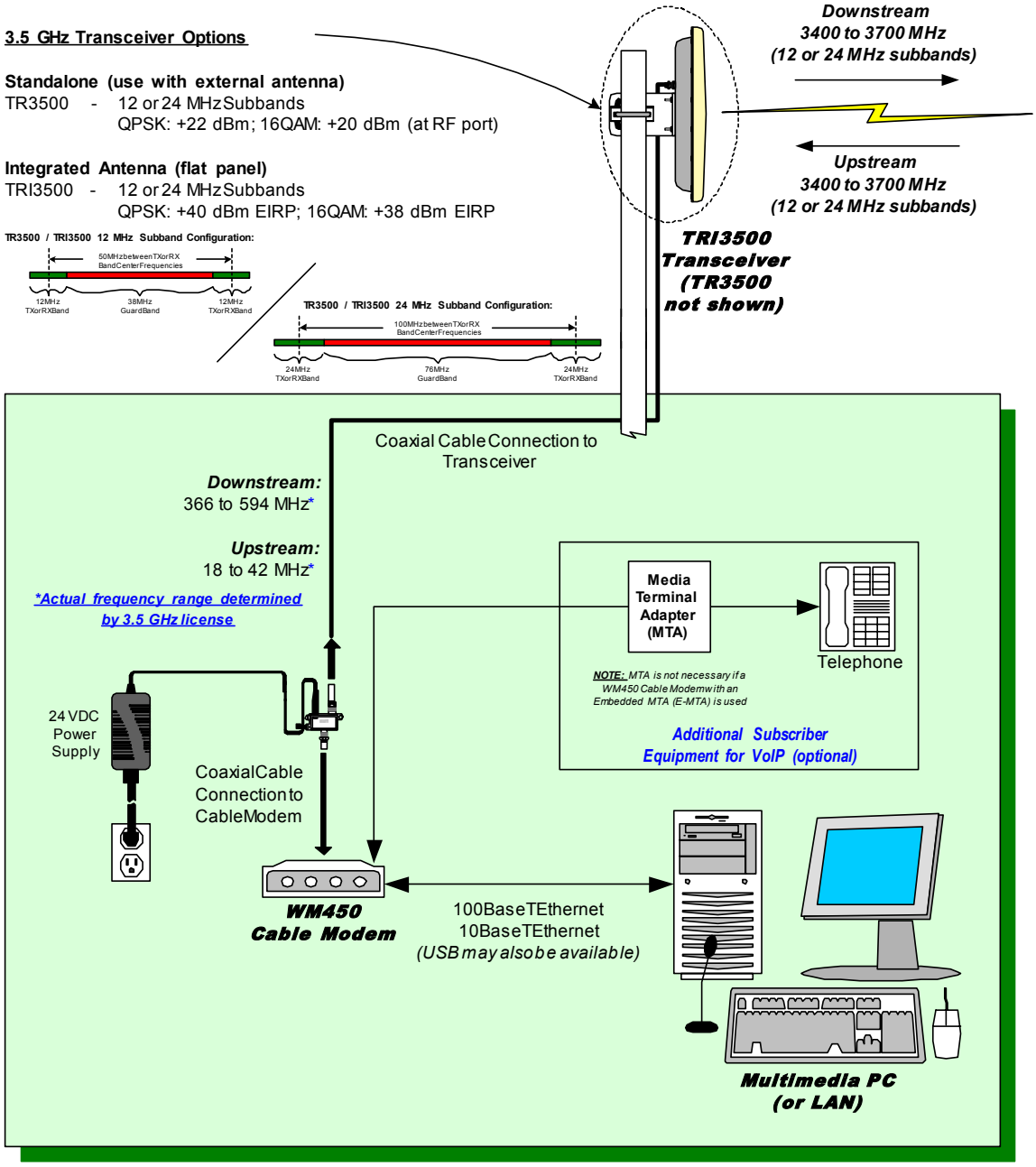

Figure 3: Point-to-Multipoint Subscriber Home/Office Detail

2.3 Element and Network Management

For smaller systems, all network and RF elements, with the exception of the subscriber RF transceivers, are fully visible on the network when using the PC Server. This unit is a Linux-based Web server configured with the Microwave History Manager (MHM) software. The MHM software offers basic logging and display of cable modem performance and usage statistics.

The optional Microwave Subscriber Manager (MSM) software offers DHCP, TFTP, customer database, individual control of cable modems, and latitude/longitude mapping support functions in addition to the basic functions available in MHM.

For larger scale systems and those requiring VoIP services, ARRIS's ALOPA subscriber management system provides all of the features required to maintain and control large numbers of subscribers. It can also be used to directly interface many of the customer billing systems available.

3 Ongoing Field Trial

ARRIS can now supply 33 different transceiver designs covering frequency bands from 500 MHz to 6 GHz.

References to customers with operational systems on four continents are available on request.

ARRIS would be pleased to demonstrate this system and to put in place any particular tests or equipment configurations to demonstrate the performance and manageability of the system.

4 Contact Information

For more information contact:

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