LWDA Network Connection Implementation

Paul S. Ray (NRL), David Munton (ARL:UT), Pat Crane (NRL), Ylva Pihlström (UNM),
Nagini Paravastu (ASEE/NRL), John Copeland (ARL:UT)

James Robnett (NRAO), Tom Baldwin (NRAO)

August 8, 2006

Abstract

We describe the internet connectivity and bandwidth requirements anticipated for the LWDA, concentrating on the first year of installation and operation.

1. Hardware Connection

The basic network architecture for connecting the LWDA to the external internet via the NRAO network is summarized in Figure 1.
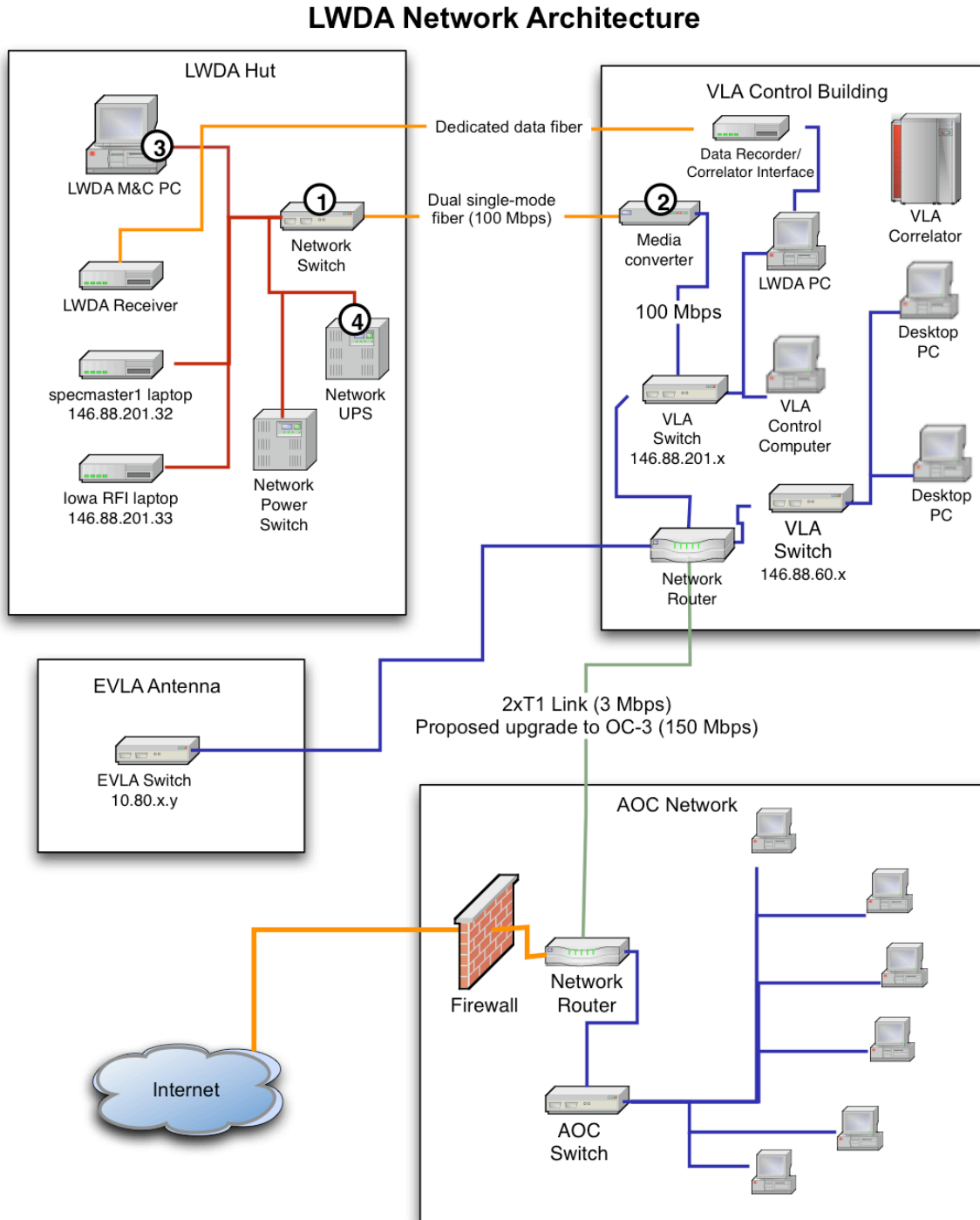
LWDA Network Architecture

Figure 1. Network architecture for the LWDA/VLA/NRAO connection.

There is a single mode fiber bundle (with 12 fibers, four of which are connected) installed from a patch panel in the VLA Control Building to the LWDA site (via the nearby EVLA antenna pad). The allocation of the fibers is: 2 for full duplex ethernet connection, 1 for streaming data from the LWDA to the VLA correlator, and 1 spare. The fiber is direct-burial ¾″ thick double armored OFS Brightwave single mode fiber. It requires a good ground connection for lightning protection. Experience at the site with ground conductivity shows that a counterpoise consisting of four 25 foot lengths of buried #6 copper wire should be sufficient [*What exactly was installed?*].

On the LWDA site side, a junction box is mounted on the 4×4 utility pole that was installed for the electrical meter. NRAO ran the fiber from where it exits the ground to the junction box in 1 ¼″ conduit and terminated the four allocated fibers with ST-type connectors. The 14″ × 14″ junction box was provided by ARL:UT and has ST bulkhead feed-through connectors mounted for the four fibers. From there, four short fibers are run from the junction box to the ST-type bulkhead feed-through connectors on the patch panel on the front of the LWDA shelter. Inside the shelter, fibers with ST connectors on one end and SC connectors on the other connect from the bulkhead feed-through to the network switch/media converter (① in Figure 1). We chose ST connectors for external connections because they are more weather resistant (particularly when wrapped with rubber tape) and easier for bulkhead feed-through connections. Inside the shelter we use SC-type connectors for their ease of use and easy availability on network hardware. We note that single-mode fiber is particularly susceptible to dirt and that all fiber connections (even new ones) should be cleaned with a fiber cleaner before connecting. In addition, we recommend a network-reachable 1.5–2 kVA APC UPS (item ④) to allow remote power cycling of the computers (and environmental monitoring).

Inside the VLA control building, the LWDA-provided singlemode fiber to twisted-pair media converter is used to make the connection from the fiber patch panel to the local ethernet (item ② in Figure 1, and Table 1). This connection is made to the 146.88.201.* subnet, and we have currently reserved the IP address range (146.88.201.32–39) for LWDA/LWA use.

The details of the unidirectional fiber data transmission from the LWDA to the VLA Correlator Room are still to be determined. However, this data transfer must be done over a dedicated fiber link because the VLA Correlator has a maximum delay capability that will not allow data transfer over any ethernet-like protocol.

For distributing ethernet to devices in the hut, unshielded Cat5 cable is probably best avoided because of RFI concerns, except for distribution within a shielded rack or enclosure, or temporary connections to laptops, etc. Around the hut, we propose to use ethernet over multimode fiber (100BASE-FX with SC connectors). A good PCI-based NIC for this purpose is the Allied Telesyn AT-2701FX/SC (item ③). Laptops can use the AT-2801FX/SC which is PCMCIA based.

There is no phone in the shelter, and it is not possible to access the EVLA VOIP network from the subnet we are on. Therefore, we recommend using Skype <http://skype.com> for internet phone service, and note that Skype calls from a computer to any phone in the US are free until

the end of 2006. We have established an LWDA site Skype account called "LWASITE" for use in the shelter.

The connection from the VLA site to the AOC is currently via 2 T1 lines connected to two Cisco Routers, which provides a total of 3 Mbps bandwidth for all traffic from the site to the AOC. An internal proposal is in preparation to upgrade this to an OC-3 fiber optic link, which would provide ~150 Mbps of bandwidth.

A list of the equipment purchased or recommended for purchase for the shelter internet connection is shown in Table 1.

Mfg. & Part #	Description	Approx. Cost
①Allied Telesyn AT-8088/SC	8-port 100baseFX/100baseTX switch with 2 expansion slots	$850
①Allied Telesyn AT-A45/SC-SM15	Single mode uplink module to go in one of the AT-8088 expansion slots	$350
②Allied Telesyn AT-MC103XL-10	Single mode to twisted pair media converter	$450
③Allied Telesyn AT-2701FX (SC)	100FX PCI Fiber Network Adapter Card (SC)	$120 each
④APC SUM1500RMXL2U with AP9619 Network Mgmt. Card	Network managed UPC, with environmental monitoring, and remote power switching capability	*Need quote*
Several possible vendors	Network remote power switch	$100–$500 depending on specs.

Table 1. Parts list for initial LWDA network connectivity.

2. Network Configuration

Devices connected to the network in the shelter should generally be set up to get their network settings via DHCP. Unknown devices, such as guest laptops, will be assigned arbitrary IP addresses on the VLA network and will have access to the internet, but will not be accessible from the outside. Devices which will be on the network for an extended time, or need to be accessed via a static IP address from the outside need to have their MAC address and a machine name registered with NRAO (via an e-mail to <u>helpdesk@aoc.nrao.edu</u>). Once this is done, the DHCP server will always assign the same IP address in our range (146.88.201.32–39) to that MAC address, and the machine will be visible to the external internet as <*machine*>.vla.nrao.edu.

The IP-accessible devices on the shelter network are shown in Table 2.

Name / Function	MAC Addr	IP Address	Services
specmaster1.vla.nrao.edu *Specmaster control laptop*	00:B0:D0:05:F3:00	146.88.201.32	SSH, RDC
ganymede.vla.nrao.edu *U. Iowa RFI monitor laptop*	00:09:6B:3F:29:E0	146.88.201.33	Labview/Web (8000)
lwda.vla.nrao.edu *LWDA control computer*	00:0C:46:FB:FA:27	146.88.201.34	SSH
lwda-pwr.vla.nrao.edu *Remote power switch*	TBD	146.88.201.37	Web (80)
lwda-ups.vla.nrao.edu *UPS Network Mgmt.*	00:C0:B7:7A:7F:53	146.88.201.38	SSH, Web (80)
lwda-at8088.vla.nrao.edu *AT-8088 Network Switch*	TBD	146.88.201.39	Web (80), Telnet?

Table 2. List of IP-accessible devices in the LWDA shelter.

3. Security

If the only service required is SSH (on port 22), no further configuration is needed since that port is open by default. If other ports for web servers, Microsoft Remote Desktop, VNC, or other services are required, the NRAO firewall must be configured to allow incoming connections for them. If possible, it is preferable to tunnel such connections via SSH. If a port must be opened, NRAO prefers to open it to connections from specific external subnets, rather than to the full internet. We certainly want to avoid making many individual requests for ports to NRAO, so please inform Paul Ray before making such requests. As much as possible, we want to plan our access needs in advance, so we can make such requests all at once.

The current network ports that are opened are summarized Table 3.

Service (Port)	From Subnet	To IP Range
SSH (TCP 22)	Any	Any
ping (ICMP), RDC (TCP 3389), Labview/Web (8000), Web (80)	**NRL**: 132.250.166.*, 132.250.122.* **ARL:UT**: 146.6.200.0–146.6.205.255 **UNM**: 64.106.63.* **Iowa**: 128.255.34.66, 128.255.32.199 **VA Tech**: 128.173.93.*, 128.173.89.*, 128.173.241.*	146.88.201.32–39

Table 3. Current network ports open at the NRAO firewall.

4. RFI Issues

[We might want to specify shielding requirements or testing requirements for network hardware at the site in this section.]

5. Network Usage Anticipated

[We might want to fill in this section with examples of how LWDA will use the network connection (e.g. what remote operation and data collection operations we will be wanting/expecting to do).]

One major use of the network connection to the LWDA site will be to perform RFI measurements and antenna characterization using laptop-controlled spectrum analyzers. Over the next several months, prototype LWA active antennas will be used to take extensive RFI data at the LWDA site. Through the network connection, the RFI measurement system can be remotely operated and monitored, and data can be downloaded by users at NRL, ARL:UT and VA Tech for analysis. The data rates are expected to be approximately four 32 kB files per minute (17.8 kbps average rate).

6. Bandwidth Estimates

For reference, the total bandwidth of the connection from the VLA site to the AOC network is 3 Mbps currently, and may increase to 150 Mbps in the future. In the following table, we provide rough estimates for the bandwidth required from the LWDA site to the external internet, as well as a separate accounting for the bandwidth required from the LWDA to the VLA control building

over the dedicated fiber for connecting to the VLA correlator. Note that the last entry (48+ months) is the expected bandwidth requirements for the full operational LWA data center to connect to the internet. Where this will be located and how this will be connected to the internet is yet to be determined.

Time Frame	Activity	Dedicated fiber BW to VLA Ctrl Bldg	Peak BW to Internet	Average BW to Internet
3–6 months	Remote operation, data retrieval	–	1 Mbps	32 kbps
6–12 months	Remote operation, data retrieval	40 Mbps	1 Mbps	64 kbps
12–48 months	Remote operation, data retrieval, connected to VLA correlator	40 Mbps	2.5 Mbps	128 kbps
48+ months (LWA operational)	M&C, data storage, data archive access	Not needed?	100 Mbps	10 Mbps

Table 2. Estimated network bandwidth requirements for LWDA/LWA

7. Costs

Beyond the items to be purchased in Table 1, are there costs that the LWA project needs to cover to pay for network access and/or bandwidth? How are these calculated and how will they be paid? Is there some shared cost for upgrading the AOC/VLA site connection?