

N H A R C

220 MHz

AllStarLink

Linking the W3PGH & W3EXW repeaters over AllStarLink

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AGENDA

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|----|------------------|---------------------------------------|
| 01 | FIRST STEPS | Two repeaters, zero link |
| 02 | THE TECHNOLOGIES | Asterisk, AllStarLink, IAX2, RIM-Lite |
| 03 | THE ARCHITECTURE | Hub-and-spoke topology |
| 04 | OUR BUILD | Hardware and software |
| 05 | LESSONS LEARNED | What bit us, what we'd tell you |
| 06 | WHERE WE ARE NOW | Current state, what's next |

FIRST STEPS

W3PGH

NODE

29370

Pi at repeater site

Publicly listed in AllStar directory

X

NO LINK

W3EXW

NODE

29344

Pi at repeater site

Publicly listed in AllStar directory

STATE

Two repeaters. Two nodes. Zero relationship.

- Each node ran independently on its own Raspberry Pi
- W3PGH users couldn't hear W3EXW users, and vice versa
- Both nodes were listed publicly in the AllStar directory

OUR GOAL

01 LINK THE REPEATERS

Audio on W3PGH retransmits on W3EXW, and vice versa. One conversation, two sites.

02 SINGLE PUBLIC FACE

Only one publicly-listed node. Internet users connect to a hub, not directly to a repeater.

03 ROOM TO GROW

Architecture that scales. Adding more 220 repeaters from neighboring clubs should be trivial.

LINKING REPEATERS WITH THE INTERNET

If repeaters could forward audio to each other over IP, a conversation on one site could travel to another.



THE IDEA

This is called **VoIP** (Voice over IP) – the same tech that powers internet phone systems.

For repeaters, we need three things:

- Software that speaks the VoIP protocol on both ends
- Hardware to bridge the radio's audio/PTT/COS signals to the computer
- A directory so repeaters can find each other by number

ASTERISK — THE ENGINE

Open-source PBX (private branch exchange). Originally built to run small office phone systems.

WHAT IT DOES

- Bridges audio between phone lines, SIP/IAX trunks, and softphones
- Handles call routing, voicemail, IVR menus, conference rooms
- Runs on Linux; started at Digium in 1999, still widely deployed today
- Extended via modules – purpose-built plugins that add new behavior

APP_RPT

The Asterisk module that makes repeater linking possible.

- Treats radio channels like phone extensions
- Adds COS/PTT handling, courtesy tones, IDing, timeouts
- Implements the "ilink" commands that connect one node to another
- Configured via `/etc/asterisk/rpt.conf`

ALLSTARLINK — THE NETWORK

Asterisk + app_rpt gets you one linked node. AllStarLink is the global network that lets all those nodes find each other.

DIRECTORY

Every public node registers at `allstarlink.org` and gets a number (ours is 29370). Other nodes look up your IP by asking a DNS-like service for that number.

NODE NUMBERS

Public numbers are assigned by AllStarLink. Private numbers (1000-1999) never hit the registry — perfect for spokes that only need to talk to one hub.

ASL3

The current generation. Packages Asterisk, `app_rpt`, and a Debian-based OS image for Raspberry Pi. Ships as a single apt-installable bundle.

IAX2 – THE PROTOCOL

How two nodes actually exchange audio. Asterisk-native; purpose-built for server-to-server voice traffic.

WHAT IT IS

Inter-Asterisk eXchange version 2

- One UDP port for everything: 4569
- Carries audio, signaling, and control on the same connection
- Built-in authentication (MD5 shared secret)
- Supports trunking – multiple calls multiplexed over one UDP flow

WHY NOT SIP?

SIP separates signaling from media (RTP). Works great for IP phones, painful across NAT.

IAX2 puts everything in one UDP flow:

- Traverses home routers cleanly
- Only one port to open/forward
- No separate media channel to lose

THE HARDWARE BRIDGE

How do analog RF signals become IP packets? A purpose-built USB interface does the translation.

RIM-LITE USB

- A small USB board with a DB-25 connector on the other side
- Plugs into the repeater controller's accessory port
- Appears to Linux as a USB audio device plus a USB HID device
- Looks identical to the RIM-LITE from RepeaterBuilder (they're the same device)

THREE SIGNALS

AUDIO (in and out)

RX audio -> Pi's sound card -> digitize

Pi sound out -> TX audio to radio

COS / COR (carrier detect)

Repeater -> Pi: "someone is keying us up"

PTT (push-to-talk)

Pi -> Repeater: "key up, I have audio"

WHY A RASPBERRY PI?

Any Linux box could do this, but Pis have become the de-facto ASL node platform.

CHEAP AND SMALL

A Pi 4 costs less than a hundred bucks and fits next to the repeater in a 1U rack. Many clubs already have one lying around.

LOW POWER

Under 5 watts at idle. Easy to back up with a small UPS or run off the same 12V supply as the radio.

OFFICIAL ASL IMAGES

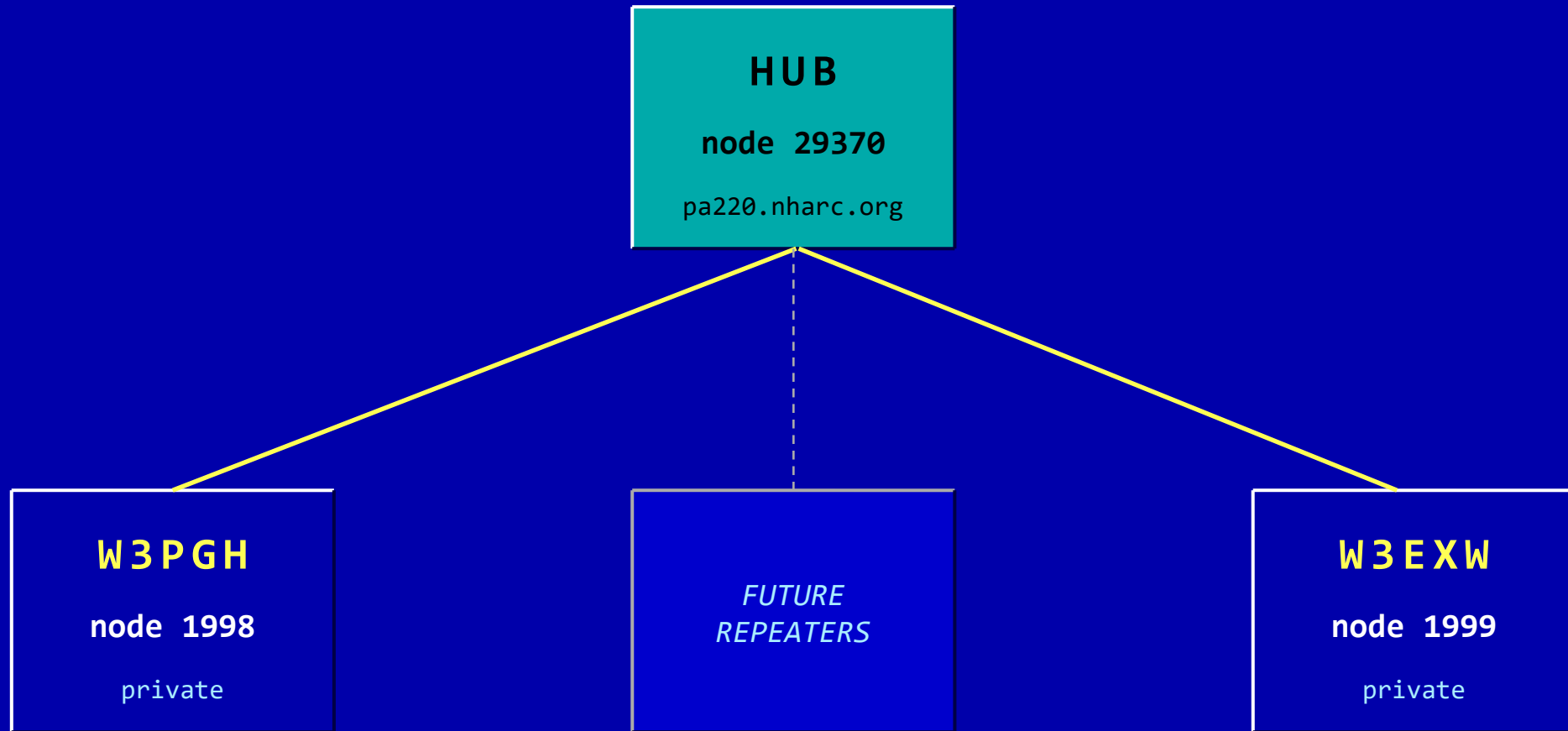
AllStarLink publishes a Debian-based Pi image with everything pre-configured. SD card in, boot, tune radio, done.

COMMUNITY

Almost every piece of documentation and tutorial assumes a Pi. If you hit a problem, someone else has probably hit it too.

OUR TOPOLOGY

Hub-and-spoke. One public node, two private spokes, room to grow.
PUBLIC



WHY HUB-AND-SPOKE?

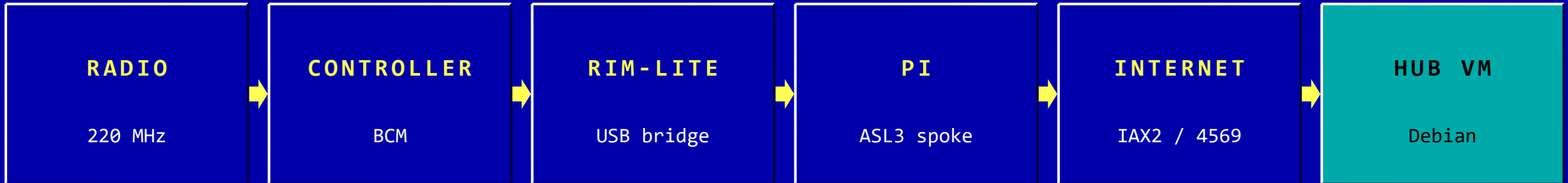
HOW IT WORKS

- Audio from any spoke is sent to the hub
- The hub rebroadcasts it to every other spoke
- Spokes don't need to know about each other
- Only the hub appears in the public AllStar directory

WHY IT MATTERS

- One hostname, one node number for the public
- Adding a repeater = adding a spoke (no reconfig of existing sites)
- Spoke Pis don't need public IPs or open ports
- Hub runs on a hosted Debian VM – stable, always-on, off-site

OUR BUILD



HUB

pa220.nharc.org

- Debian 12 on a rented VM
- ASL3 3.8.3
- Public node 29370
- No radio hardware

SPOKES (×2)

Pi at each repeater site

- Debian 12 on Raspberry Pi 4
- ASL3 3.8.3 + usbradio driver
- Private nodes 1998 (W3PGH) and 1999 (W3EXW)
- Auto-connect to hub at startup

LESSONS LEARNED

We do these things not because they are easy, but because we thought they would be easy

UPSTREAM BUGS BEAT YOUR CONFIG

Hours lost to an `app_rpt` assertion bug that was already fixed in the ASL3 beta repo. Check the project's issue tracker before assuming you're holding it wrong.

Fix: *Pulled ASL3 3.8.3 from bookworm main beta.*

DEFAULT CONFIGS LIE

The `*813 "permanent connect" ilink` command is shipped commented out in `rpt.conf`. `startup_macro` needs it to work. No error was logged – it just quietly refused to fire.

Fix: *Uncomment the line. Also pad `startup_macro` with 20 half-second pauses so `app_rpt` is ready when the macro fires.*

ONE LINE CAN LIE TO YOU

W3EXW had one-way audio. Identical config to W3PGH, which worked. We chased COS signals, cabling, and LEDs for hours before a fresh set of eyes spotted it.

Fix: *`repeater=1` was missing from `usbradio.conf`. One line, buried in a file we'd already read fifty times.*

WHERE WE ARE NOW

OK

HUB ONLINE

pa220.nharc.org, node 29370

OK

W3PGH SPOKE

node 1998, two-way audio

OK

W3EXW SPOKE

node 1999, two-way audio

OK

CROSS-REPEATER AUDIO

both sides hear each other

OK

AUTO-RECONNECT

spokes rejoin after reboot or netblip

OK

PUBLIC DIRECTORY

only the hub is listed

SUMMARY

2 repeaters -> **1** conversation

WHAT'S NEXT

MORE SPOKES

Neighboring clubs' 220 repeaters are an obvious next addition. Each new site is one more private node number and one line in the hub's config.

MONITORING

Lightweight uptime and audio checks on the hub. Alerts when a spoke drops so we know before users do.

DOCUMENTATION

Full blog writeup is live at kb3lyb.com. Next: a one-page "bring up a new spoke" runbook any club tech can follow.

OPERATING CONVENTIONS

Linked repeaters come with linked-repeater etiquette questions – IDing, timeouts, courtesy pauses. Worth a separate club discussion.

RESOURCES

Further reading for anyone who wants to dig deeper.

AllStarLink	<code>allstarlink.org</code>	Node registration, documentation, download images
ASL3 Docs	<code>docs.allstarlink.org</code>	Installation, configuration, troubleshooting
app_rpt	<code>github.com/AllStarLink/app_rpt</code>	The Asterisk module source and issue tracker
Asterisk	<code>asterisk.org</code>	The underlying PBX – documentation and community
This Build	<code>kb3lyb.com</code>	Full writeup of the NHARC deployment, including config files

Questions?

Credits

Mark Earnest **KB3LYB** — Pi / RIM-Lite / software setup

Ed DeHart **WA3YOA** — Repeater hardware setup

Stephen Zelenko **N3ZX** — Testing and troubleshooting

Hey now, you're an AllStar, get your gain on, go play