

# Introduction to the WSR-88D

## *Introduction*

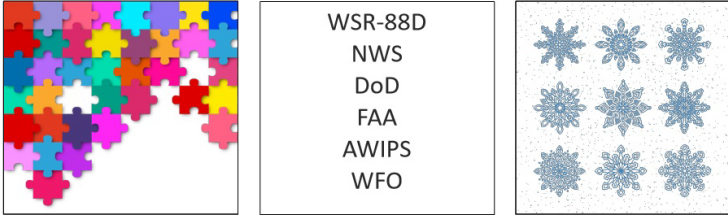


### **Notes:**

Welcome to this lesson, Introduction to the Weather Surveillance Radar - 88 Doppler (WSR-88D). Let's get started.

## Key Points to Know about This Lesson

### Key Points to Know about This Lesson



How components fit together      Introduce common acronyms      Show system variability

### Notes:

You have just started the Radar & Applications Course, and we begin with this introductory lesson on the WSR-88D. While it makes sense to start a large course would start with an introduction, what we are introducing may not be clear at first. So, let me explain:

1. First, we are introducing you to the different components that make up the WSR-88D and how they fit together. It's like a big jigsaw puzzle. As we tell you about these different pieces of the system, we try to do so with limited details. It's kind of like a 10,000 foot view of each component and how they fit together. The details we do provide are primarily examples that may be included on the test at the lesson.
2. We also will be introducing you to a LOT of acronyms. We will not ask you to regurgitate what these acronyms are. However, you are going to get exposed to a lot of acronyms during your time of government service, and the WSR-88D (which is itself an acronym) has many components, applications, and related practices that use these terms. What we include is our institution jargon, so we are just ripping the band-aid off now to help you get used to it.
3. The last thing we are introducing is the variability in the system. This radar network is owned and maintained by three federal agencies (NWS, Dept. of Defense, and the FAA). Your office may have access to and control of radars with different configurations due to which agency owns that particular radar or certain restrictions and requirements that had to be met when siting the system. Even if some of these details don't apply to your local radar, these details bring awareness to the variability of the different radars in the vast WSR-88D network.

## ***The WSR-88D System Basics***

### **The WSR-88D System Basics**

- Radar Data Acquisition Unit (RDA)
- Wideband Communications between the RDA and The Radar Product Generator
- Radar Product Generator (RPG)
- Master System Control Function (MSCF)
- Product Distribution Communications
- User Systems (e.g., Advanced Weather Interactive Processing System)



### **Notes:**

The WSR-88D system contains several data processing, control, and display components. Some of these units also employ multiple subcomponents. NWS forecasters should have a basic understanding of the WSR-88D system in order to effectively produce the best quality radar data. This understanding includes knowledge of the components (and subcomponents), their relationship to each other, and the flow of data through the system. These six different components are:

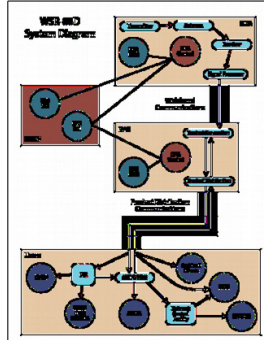
- Radar Data Acquisition Unit (RDA),
- Wideband Communications between the RDA and The Radar Product Generator,
- Radar Product Generator (RPG),
- Master System Control Function (MSCF),
- Product Distribution Communications, and
- User Systems (e.g., Advanced Weather Interactive Processing System).

(Crum et al., 1993; Crum et al., 1998)

## Note on System Diagram Links

### Note on System Diagram Links

- Located on bottom of each slide
- Open up images as a lightbox
- Not necessary to visit (only provided to assist)



[Click to view system diagram](#)


### Notes:

As you go through this lesson, most of the slides will have a link in the lower left saying "Click to view system diagram". These images will appear in a lightbox on top of the slide, and highlight where the current content fits into the WSR-88D system as a whole. It's not necessary to visit each of these images, but may help orient you if you get confused as to where a certain component fits in the system at large.

## ***Radar Data Acquisition Unit (RDA)***

### **Radar Data Acquisition Unit (RDA)**

- Origination point of radar data you will use
- Consists of 5 subcomponents:
  - Transmitter
  - Antenna
  - Receiver
  - Signal Processor
  - KVM Interface



[Click to view system diagram](#)

### **Notes:**

The Radar Data Acquisition Unit (or RDA) is the origination point of the radar data that you, the operator, will ultimately use. The RDA component group includes five primary subcomponents:

- Transmitter,
- Antenna,
- Receiver,
- Signal processor, and
- Keyboard-Video-Mouse (KVM) and Monitor Interface.

These subcomponents work together to generate and radiate radio frequency (RF) pulses, receive reflected energy from those pulses, and process this received energy into digital base data.

## ***Transmitter***

### **Transmitter**

- First step in process
- 10 cm wavelength pulse, 750 kW peak power
- Allows for collection of base moments & dual-pol variables



[Click to view system diagram](#)

### **Notes:**


The first step in acquiring radar data is the transmission of a radio frequency (RF) signal. The WSR-88D uses a RF signal transmitted from a klystron amplifier. The klystron amplifier produces a coherent signal with a precisely controlled amplitude, frequency, and phase. The WSR-88D transmits this high frequency signal using an approximately 10 cm wavelength RF pulse at a peak power of 750 kW. These specifications allow for collection of base moments (Reflectivity, Velocity, and Spectrum Width), as well as dual-polarization variables (Differential Reflectivity, Correlation Coefficient, and Differential Phase) of sufficient quality for current NWS purposes.

(Heiss et al., 1990; Bringi and Chandrasekar, 2001; Curtis, et al., 2003)

## Antenna

### Antenna

- Volume Coverage Patterns
- Pulses
- Operational Modes
- AVSET
- SAILS
- MRLE



- Broadcasts pulse & intercepts returned energy
- VCPs can position at various elevation angles
- Learn more about antenna using buttons to the left

[Click to view system diagram](#)

### Notes:

**Main Slide:** The antenna broadcasts the RF signal out into the atmosphere and intercepts returning energy. The antenna transmits a RF signal polarized at a 45 degree angle (i.e., polarized in the horizontal and vertical direction).

The antenna elevation position has a wide possible range (i.e., anywhere from - 1.0 to 60.0 degrees) for scanning purposes. The Volume Coverage Pattern (VCP), the operational mode in use, and the use of three different dynamic scanning strategy applications determine the antenna angles used to collect data. You can learn more about these by clicking on the buttons left of the image.

Here's an important note...The radar operator cannot manually position the radar antenna at a given elevation or azimuth. So, you should choose wisely when selecting a VCP and any dynamic scanning strategies.

## Volume Coverage Patterns (Slide Layer)

### Antenna

- Volume Coverage Patterns
- Pulses
- Operational Modes
- AVSET
- SAILS
- MRLE

	VCP 31	VCP 35	VCP 12	VCP 112	VCP 212	VCP 215
# of tilts (full)	5	9	15	15	15	15
Clear Air/ Precip	Clear Air	Clear Air	Precip	Precip	Precip	Precip
SZ-2/MPDA	No	No	SZ-2	SZ-2/ MPDA	SZ-2	SZ-2
SAILS/MRLE	0/0	1/0	3/4	1/4	3/4	1/4

- VCP = Volume Coverage Pattern
- Specify elevation angles antenna will scan
- 6 VCPs currently available

[Click to view system diagram](#)

**Volume Coverage Patterns:** The Volume Coverage Pattern specifies the actual elevation angles the antenna will scan (e.g., 0.5°, 1.5°) in a specified period of time. The WSR-88D currently has six operational VCPs. They are:

- VCP 12 – Which samples up to 15 elevations (0.5° elevation potentially scanned up to four times when SAILS is enabled) during the 4.5 minute volume scan.
- VCP 112 - Samples up to 15 elevations (0.5° elevation scanned two times when SAILS is enabled) during the 5.5 minute volume scan that uses the Multi-PRF Dealiasing Algorithm (MPDA) on the lowest 3 elevations.
- VCP 31 - Samples 5 elevations during the 10 minute volume scan.
- VCP 35 - Samples 9 elevations (0.5° elevation scanned two times when SAILS is enabled) during the 7 minute volume scan using the SZ-2 range unfolding algorithm on the lowest 3 elevations.
- VCP 212 - Samples up to 15 elevations (0.5° elevation scanned up to four times when SAILS is enabled) during the 4.5 to 5 minute volume scan using the SZ-2 range unfolding algorithm on the lowest 3 elevations.
- VCP 215 - Samples up to 15 elevations (0.5° elevation scanned two times when SAILS is enabled) during the 7 minute volume scan using the SZ-2 range unfolding algorithm on the lowest 3 elevations.

(Crum et al., 1993; Brown et al., 2005; Boettcher et al., 2022)



## Pulses (Slide Layer)

### Antenna

- Volume Coverage Patterns
- Pulses**
- Operational Modes
- AVSET
- SAILS
- MRLE

Pulses

• Long pulse:

- Pro: Increases radar sensitivity
- Con: Poorer quality Doppler velocity

[Click to view system diagram](#)

**Pulses:** VCP 31 uses a long pulse (4.7 microseconds), while all the other VCPs use short pulse (1.57 microseconds). Longer pulses increase the sensitivity of the radar, but result in poorer Doppler velocity data.

## Operational Modes (Slide Layer)

### Antenna

- Volume Coverage Patterns
- Pulses
- Operational Modes**
- AVSET
- SAILS
- MRLE

Operational Modes

- Clear Air: VCPs 31 or 35
- Precipitation: VCPs 12, 112, 212, or 215

[Click to view system diagram](#)

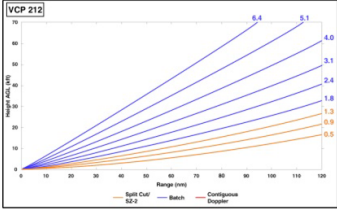
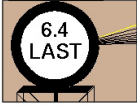
**Operational Modes:** In addition to VCPs, the WSR-88D has two operational modes which play a part in antenna positioning: Clear Air mode and Precipitation mode. The operational mode of the radar determines which VCPs are available to be used. For example:

- Clear Air mode offers VCPs 31, or 35
- Precipitation mode offers VCPs 12, 112, 212, or 215.

## AVSET (Slide Layer)

### Antenna

- Volume Coverage Patterns
- Pulses
- Operational Modes
- AVSET
- SAILS
- MRLE



- AVSET = Automated Volume Scan Evaluation & Termination
- Allows for early termination of a VCP if no radar echoes
- VCPs ~30 sec shorter w/AVSET enabled, on average
- Doesn't run in clear air mode VCPs

[Click to view system diagram](#)

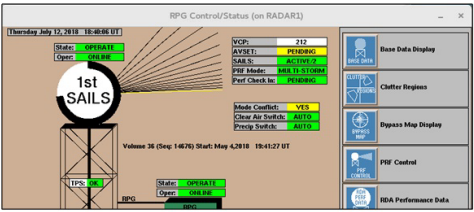
**AVSET:** VCPs determine the elevation angles that the radar scans, but WSR-88D operators have the ability to implement "dynamic" scanning techniques, too. The first dynamic scanning technique we will discuss is the Automated Volume Scan Evaluation and Termination (or AVSET; Chrisman, 2009). This application can stop a VCP if there is no relevant weather data at higher tilts. Use of AVSET on WSR-88D sites throughout the U.S. has allowed for an approximately 30 second decrease, on average, in scanning time of precipitation mode VCPs.

AVSET only removes elevation angles above 6.4°. As a result, AVSET doesn't run during any Clear Air mode VCPs. The radar operator controls AVSET at the Master System Control Function (MSCF) or at the AWIPS Workstation.

## SAILS (Slide Layer)

### Antenna

- Volume Coverage Patterns
- Pulses
- Operational Modes
- AVSET
- SAILS
- MRLE



The screenshot shows the 'RPG Control/Status (on RADAR)' window. It features a central radar display with a '1st SAILS' label and a radar tower icon. To the right of the radar, there are several status indicators: 'VCP: 212', 'AVSET: PENDING', 'SAILS: OPERATIONAL', 'PDP Mode: 804.11.1000', and 'Part Check: OK'. Below these, there are more status indicators: 'Mode Control: YES', 'Clear Air Traffic: AUTO', and 'PDP Status: AUTO'. At the bottom of the window, it says 'Volume 36 (Seq 1467) Start: May 4, 2010 10:41:27 UT'. On the right side of the window, there are several buttons: 'Base Data Display', 'Chatter Region', 'Display Map Display', 'PDP Control', and 'RDA Performance Data'. At the bottom left of the screenshot, there is a 'Status: OPERATIONAL' and 'Open: 10:41:27 UT' indicator.

- SAILS: Supplemental Adaptive Intra-Volume Low-Level Scan
- Allows for additional lowest level tilt scans in a VCP
  - 3 additional tilts in VCPs 12 & 212
  - 1 additional tilt in VCPs 35, 112, & 215

[Click to view system diagram](#)

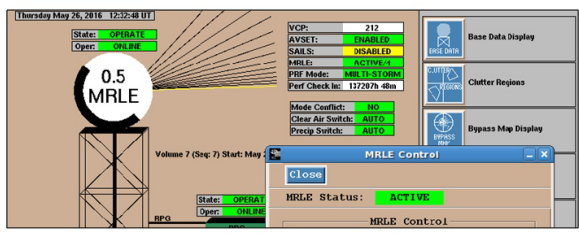
**SAILS:** Another dynamic scanning feature available in certain VCPs is called the Supplemental Adaptive Intra-Volume Low-Level Scan (or SAILS; Chrisman, 2013). During severe weather operations (for which VCPs 12 and 212 were designed), SAILS allows the WSR-88D to behave like a Terminal Doppler Weather Radar (or TDWR) by adding up to three additional low level (0.5 degrees for most sites) scans at regular intervals during the volume scan. In VCPs 35, 112, and 215, a single SAILS tilt can be enabled. When SAILS is enabled for these scanning strategies, one additional lowest level tilt will be added to the middle of the volume scan.

The radar operator controls the use of SAILS at the MSCF or at the AWIPS Workstation.

## MRLE (Slide Layer)

**Antenna**

Volume Coverage Patterns  
 Pulses  
 Operational Modes  
 AVSET  
 SAILS  
 MRLE



Volume 7 (Seq: 7) Start: May 25, 2016 17:39:48 [U]

State: OPERATE  
Oper: MRLE

VCP: 212  
AVSET: DISABLED  
SAILS: DISABLED  
MRLE: ACTIVE  
PRF Mode: MRLE STOPPED  
Part Check In: 1172078 40m

Mode Conflict: NO  
Clear Air Switch: AUTO  
Precip Switch: AUTO

MRLE Control

MRLE Status: ACTIVE

MRLE Control

- MRLE = Mid-Volume Rescan of Low-Level Elevations
- Can add an extra scan of up to 4 lowest tilts in VCP
- Can't run MRLE & SAILS at same time

[Click to view system diagram](#)

**MRLE:** The latest dynamic scanning feature added to the WSR-88D is the Mid-Volume Rescan of Low-Level Elevations (MRLE; Chrisman, 2016). During severe weather operations, MRLE can be used to collect an extra scan of up to the lowest four tilts in the volume scan. Like SAILS, these extra tilts are collected during the middle portion of the volume scan. MRLE and SAILS cannot be enabled concurrently, so you have to choose one option or the other.

The radar operator controls the use of MRLE at the MSCF or AWIPS workstation.

## Receiver

### Receiver

- Backscattered energy returned to antenna gets routed to the receiver
- Receiver listens for returned signal:
  - Horizontal
  - Vertical
- Amplifies, adjusts, and digitizes signal
- Captures the necessary amplitude & phase data



[Click to view system diagram](#)


### Notes:

As the antenna intercepts returning (backscattered) energy, it routes the energy, or returned signal, to the receiver. The WSR-88D receiver "listens" for data in both the horizontal and vertical channels simultaneously. The returned signal contains far less energy than the originally transmitted signal. To aid in processing, the receiver amplifies the returned signal, adjusts its frequency, and then digitizes the signal using an Intermediate Frequency Digital Receiver (IFDR). In this process, the receiver captures the amplitude and phase information needed to compute all of the base data moments and dual-polarization base data.

## Signal Processor

### Signal Processor

- Clutter Filtering
- Base Data
- Range Unfolding
- Level 1 Archive



- Signal processor performs:
  - Ground clutter suppression
  - Calculation of base data
  - Range unfolding of Doppler velocity data

[Click to view system diagram](#)

### Notes:

**Main Slide:** Upon reception of the digitized output from the receiver, the radar signal processor (also called the RSP) accomplishes three important functions:

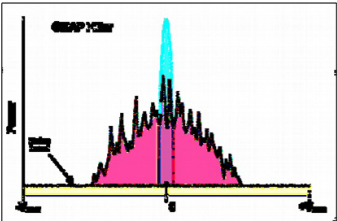
- ground clutter suppression,
- calculation of base data, and
- range unfolding of Doppler velocity data.

Additionally, Archive Level I recording - if performed - occurs at the signal processor. Click on the buttons left of the image to learn more about these functions.

## Clutter Filtering (Slide Layer)

### Signal Processor

- Clutter Filtering
- Base Data
- Range Unfolding
- Level 1 Archive



- Involves two applications:
  - CMD = Clutter Mitigation Decision (identifies clutter)
  - GMAP = Gaussian Model Adaptive Processing (removes clutter & rebuilds signal)

[Click to view system diagram](#)

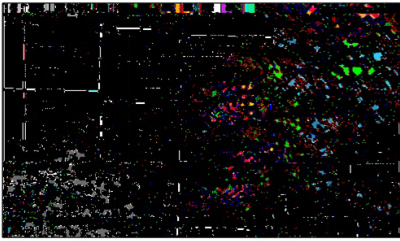
**Clutter Filtering:** Most ground targets have little or no motion. This trait, when applicable, distinguishes ground targets from most atmospheric scatterers (Chrisman et al., 1995). However, ground clutter can be identified by other important characteristics. Variables used to identify these characteristics include reflectivity texture, clutter phase alignment, and standard deviations of Differential Reflectivity (ZDR) and Differential Phase (Phi). The Clutter Mitigation Decision (CMD; Ice et al., 2007) algorithm uses these variables to detect areas of clutter on an elevation-by-elevation, bin-by-bin basis of every volume scan.

Once areas of clutter are identified, the Gaussian Model Adaptive Processing (GMAP; Passarelli and Siggia, 2004) algorithm uses Spectrum Width data to suppress the ground clutter contaminated portion of the signal. GMAP removes power from the returned signal within a very narrow width centered at zero velocity. Depending on the availability of returns from meteorological targets outside this width, GMAP then rebuilds an estimated weather signal that replaces the initially removed data.

## Base Data (Slide Layer)

### Signal Processor

- Clutter Filtering
- Base Data
- Range Unfolding
- Level 1 Archive



- Base moments (base reflectivity, base radial velocity, & base spectrum width)
- Dual-polarization base data (correlation coefficient, differential reflectivity, & differential phase)

[Click to view system diagram](#)

**Base Data:** After clutter suppression, three base moments are built. These moments are:

- base reflectivity,
- base radial velocity, and
- base spectrum width.

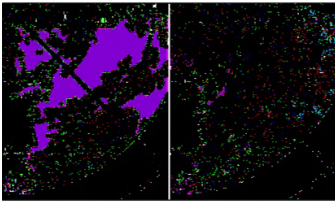
In addition to these moments, the signal processor calculates the dual-polarization base data. The dual-polarization data differ in character from the legacy base data and, as a result, are not considered to be a base moment. However, these data are one of four base data streams sent to the Radar Product Generator (or RPG) for generating radar products.



## Range Unfolding (Slide Layer)

### Signal Processor

- Clutter Filtering
- Base Data
- Range Unfolding**
- Level 1 Archive



- Addresses issues from multiple trip echoes
- Three techniques used:
  - Legacy Range Unfolding Algorithm
  - Sachidananda-Zrnic-2 (SZ-2)
  - Multi-PRF Dealiasing Algorithm

[Click to view system diagram](#)


**Range Unfolding:** Multiple trip echoes cause a phenomenon known as range folding. Range folding occurs frequently in the velocity and spectrum width data due to the high pulse repetition frequencies (PRFs) that are used. Range unfolding is the process of “unfolding” these returns to their appropriate ranges. The unfolding process uses a comparison of base reflectivity (low PRF) and base velocity (high PRF). The Signal Processor can use three range unfolding techniques: the Legacy Range Unfolding Algorithm, the Sachidananda-Zrnic (SZ)-2 Range Unfolding Algorithm, and the Multi-PRF Dealiasing Algorithm. The latter two techniques’ availability and use depends on the particular elevation angle and VCP being processed.

(Conway et al., 1997; Sachidananda and Zrnic, 1999; Zrnic et al., 2006)

## Level 1 Archive (Slide Layer)

### Signal Processor

- Clutter Filtering
- Base Data
- Range Unfolding
- Level 1 Archive




- Archive Level I is returned signal data in digital format
- Available at all sites

[Click to view system diagram](#)

**Level 1:** The WSR-88D has the ability to record the original returned signal in a digital format (i.e., Archive Level I). Archive Level I recorders have been available at all RDAs since the fielding of RDA/RPG Build 19. The data recorder is a two terabyte removable drive.

## *KVM & Monitor Interface*

### KVM & Monitor Interface



- KVM = Keyboard Video Mouse
- Allows for local access to RDA
- NWS forecasters will likely never interact with this subcomponent

[Click to view system diagram](#)

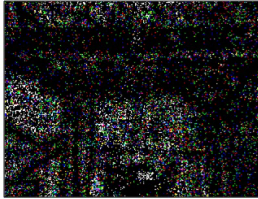
### Notes:

The Keyboard Video Mouse (KVM) and Monitor Interface is used to control the RDA locally (i.e., at the RDA shelter) and to monitor RDA maintenance functions. Each RDA shelter contains a KVM and Monitor Interface. Many of the KVM and Monitor Interface control functions can also be performed remotely via the RDA Human Computer Interface (HCI) at the Master System Control Function (MSCF). In general, NWS forecasters will never have to interact with this subcomponent of the RDA.

## ***“Wideband” Communications***

### **“Wideband” Communications**

- Direct Wire Link
- Private T1
- Commercial T1
- Backup Comms



- Base data transmission lines between RDA & RPG
- Can be one of three options:
  - Direct Wire link
  - Private T1
  - Commercial T1 (Telco)

[Click to view system diagram](#)

### **Notes:**

**Main Slide:** The RDA and the RPG link together through a “wideband” communications line that provides high speed, full duplex (simultaneous, two-way) data transmission. These communication lines transmit the four channels of base data (reflectivity, velocity, spectrum width, and dual-polarization) from the RDA to the RPG. Depending on the distance between the RDA and RPG (and the locally available services), the primary wideband link for a particular WSR-88D site may be any one of the following:

- Direct Wire Link,
- Private T1, or
- Telco (Commercial) T1.


Approximately half of WSR-88D sites also have a backup wideband communications link in case the primary link fails for some reason. The backup wideband comms available include:

- Wireless cellular data (currently 4G), or
- Very Small Aperture Terminal (VSAT).

## Direct Wire Link (Slide Layer)

**“Wideband” Communications**

- Direct Wire Link
- Private T1
- Commercial T1
- Backup Comms



- Used when RDA & RPG less than 400 ft apart
- DoD & FAA sites use this connectivity for primary link


[Click to view system diagram](#)

**Direct Wire Link:** Direct wire links connect the RDA and RPG when the distance between them is less than 400 feet. This WSR-88D configuration occurs most often when the RPG is located in the RDA shelter. All Department of Defense (DoD) and Federal Aviation Administration (FAA) sites use this type of connectivity for their primary link.

## Private T1 (Slide Layer)

**“Wideband” Communications**

- Direct Wire Link
- Private T1
- Commercial T1
- Backup Comms



- Used when RDA & RPG 400-3000 ft apart
- Primarily used when RDA adjacent to a NWS WFO
- About half of NWS sites use this link


[Click to view system diagram](#)

**Private T1:** This type of wideband link is used when the distance between the RDA and RPG is between 400 and 3000 feet. This configuration link occurs most commonly when the RDA is adjacent to the NWS Weather Forecast Office (WFO). Approximately half of the NWS WSR-88D site connections use this type of primary communications link.

## Commercial T1 (Slide Layer)

**“Wideband” Communications**

- Direct Wire Link
- Private T1
- Commercial T1**
- Backup Comms



- Used when RDA & RPG too far apart for Private T1
- About half of NWS sites use this link

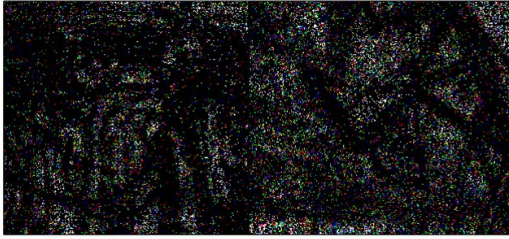
[Click to view system diagram](#)

**Commercial T1:** This type of wideband link is used when the distance between the RDA and RPG is too far for a Private T1. The Radar Operations Center (ROC) leases transmission medium from local telecommunications companies to link the RDA and RPG over an unlimited distance. Approximately half of the NWS WSR-88D site connections use this class of primary wideband comms link. In addition, several DoD and FAA radars also have a separate commercial link to NWS offices if those offices have the MSCF (and the RPG is still in the RDA shelter).

## Backup Comms (Slide Layer)

**“Wideband” Communications**

- Direct Wire Link
- Private T1
- Commercial T1
- Backup Comms



- Sites with Telco also have backup comms
- Two options:
  - Cellular connection (4G)
  - VSAT

[Click to view system diagram](#)

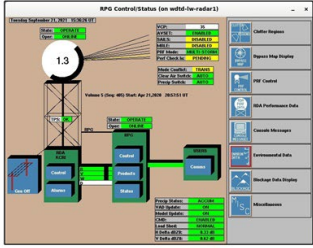
**Backup Comms:** RPGs that rely on commercial T1 service for their wideband link (or linking the RPG to the MSCF) also have a backup communication system. These backup systems use one of the following methods to transfer data between the two sites:

- Cellular data connection (currently 4G) or
- Very Small Aperture Terminal (VSAT).

Backup communications use 4G wireless data in areas where it is available. Other sites rely on VSAT (which is a satellite communications system).

## Radar Product Generator (RPG)

**Radar Product Generator (RPG)**



The screenshot displays the RPG Control/Status interface. It features a central radar station diagram with a circular radar display showing a '1.3' value. To the right of the diagram is a control panel with various buttons and indicators. Below the diagram, there is a table of system parameters and a list of system messages.

- RPG ingests & processes base data from RDA
- Controlled at the MSCF
- Creates base & derived products, then distributes to different users

[Click to view system diagram](#)

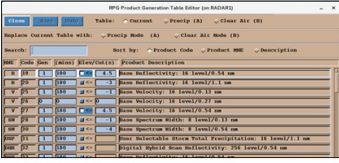
### Notes:

The RPG ingests and processes the base data received from the RDA via wideband communications. The NWS radar operator controls the RPG using the MSCF. The RPG generates a suite of base and derived products and then distributes the products to the different users through a variety of product distribution communications.

(Crum, 1998; Radar Operations Center, 2018)

## Product Generation

### Product Generation



ID	Code	Units	Units/Alt	Product	Description
001	REF	dBZ	dBZ	Base Reflectivity	10 Level/2.5 km
002	REF	dBZ	dBZ	Base Reflectivity	10 Level/3.0 km
003	REF	dBZ	dBZ	Base Reflectivity	10 Level/3.5 km
004	REF	dBZ	dBZ	Base Reflectivity	10 Level/4.0 km
005	REF	dBZ	dBZ	Base Reflectivity	10 Level/4.5 km
006	REF	dBZ	dBZ	Base Reflectivity	10 Level/5.0 km
007	REF	dBZ	dBZ	Base Reflectivity	10 Level/5.5 km
008	REF	dBZ	dBZ	Base Reflectivity	10 Level/6.0 km
009	REF	dBZ	dBZ	Base Reflectivity	10 Level/6.5 km
010	REF	dBZ	dBZ	Base Reflectivity	10 Level/7.0 km
011	REF	dBZ	dBZ	Base Reflectivity	10 Level/7.5 km
012	REF	dBZ	dBZ	Base Reflectivity	10 Level/8.0 km
013	REF	dBZ	dBZ	Base Reflectivity	10 Level/8.5 km
014	REF	dBZ	dBZ	Base Reflectivity	10 Level/9.0 km
015	REF	dBZ	dBZ	Base Reflectivity	10 Level/9.5 km
016	REF	dBZ	dBZ	Base Reflectivity	10 Level/10.0 km
017	REF	dBZ	dBZ	Base Reflectivity	10 Level/10.5 km
018	REF	dBZ	dBZ	Base Reflectivity	10 Level/11.0 km
019	REF	dBZ	dBZ	Base Reflectivity	10 Level/11.5 km
020	REF	dBZ	dBZ	Base Reflectivity	10 Level/12.0 km
021	REF	dBZ	dBZ	Base Reflectivity	10 Level/12.5 km
022	REF	dBZ	dBZ	Base Reflectivity	10 Level/13.0 km
023	REF	dBZ	dBZ	Base Reflectivity	10 Level/13.5 km
024	REF	dBZ	dBZ	Base Reflectivity	10 Level/14.0 km
025	REF	dBZ	dBZ	Base Reflectivity	10 Level/14.5 km
026	REF	dBZ	dBZ	Base Reflectivity	10 Level/15.0 km
027	REF	dBZ	dBZ	Base Reflectivity	10 Level/15.5 km
028	REF	dBZ	dBZ	Base Reflectivity	10 Level/16.0 km
029	REF	dBZ	dBZ	Base Reflectivity	10 Level/16.5 km
030	REF	dBZ	dBZ	Base Reflectivity	10 Level/17.0 km
031	REF	dBZ	dBZ	Base Reflectivity	10 Level/17.5 km
032	REF	dBZ	dBZ	Base Reflectivity	10 Level/18.0 km
033	REF	dBZ	dBZ	Base Reflectivity	10 Level/18.5 km
034	REF	dBZ	dBZ	Base Reflectivity	10 Level/19.0 km
035	REF	dBZ	dBZ	Base Reflectivity	10 Level/19.5 km
036	REF	dBZ	dBZ	Base Reflectivity	10 Level/20.0 km
037	REF	dBZ	dBZ	Base Reflectivity	10 Level/20.5 km
038	REF	dBZ	dBZ	Base Reflectivity	10 Level/21.0 km
039	REF	dBZ	dBZ	Base Reflectivity	10 Level/21.5 km
040	REF	dBZ	dBZ	Base Reflectivity	10 Level/22.0 km
041	REF	dBZ	dBZ	Base Reflectivity	10 Level/22.5 km
042	REF	dBZ	dBZ	Base Reflectivity	10 Level/23.0 km
043	REF	dBZ	dBZ	Base Reflectivity	10 Level/23.5 km
044	REF	dBZ	dBZ	Base Reflectivity	10 Level/24.0 km
045	REF	dBZ	dBZ	Base Reflectivity	10 Level/24.5 km
046	REF	dBZ	dBZ	Base Reflectivity	10 Level/25.0 km
047	REF	dBZ	dBZ	Base Reflectivity	10 Level/25.5 km
048	REF	dBZ	dBZ	Base Reflectivity	10 Level/26.0 km
049	REF	dBZ	dBZ	Base Reflectivity	10 Level/26.5 km
050	REF	dBZ	dBZ	Base Reflectivity	10 Level/27.0 km
051	REF	dBZ	dBZ	Base Reflectivity	10 Level/27.5 km
052	REF	dBZ	dBZ	Base Reflectivity	10 Level/28.0 km
053	REF	dBZ	dBZ	Base Reflectivity	10 Level/28.5 km
054	REF	dBZ	dBZ	Base Reflectivity	10 Level/29.0 km
055	REF	dBZ	dBZ	Base Reflectivity	10 Level/29.5 km
056	REF	dBZ	dBZ	Base Reflectivity	10 Level/30.0 km
057	REF	dBZ	dBZ	Base Reflectivity	10 Level/30.5 km
058	REF	dBZ	dBZ	Base Reflectivity	10 Level/31.0 km
059	REF	dBZ	dBZ	Base Reflectivity	10 Level/31.5 km
060	REF	dBZ	dBZ	Base Reflectivity	10 Level/32.0 km
061	REF	dBZ	dBZ	Base Reflectivity	10 Level/32.5 km
062	REF	dBZ	dBZ	Base Reflectivity	10 Level/33.0 km
063	REF	dBZ	dBZ	Base Reflectivity	10 Level/33.5 km
064	REF	dBZ	dBZ	Base Reflectivity	10 Level/34.0 km
065	REF	dBZ	dBZ	Base Reflectivity	10 Level/34.5 km
066	REF	dBZ	dBZ	Base Reflectivity	10 Level/35.0 km
067	REF	dBZ	dBZ	Base Reflectivity	10 Level/35.5 km
068	REF	dBZ	dBZ	Base Reflectivity	10 Level/36.0 km
069	REF	dBZ	dBZ	Base Reflectivity	10 Level/36.5 km
070	REF	dBZ	dBZ	Base Reflectivity	10 Level/37.0 km
071	REF	dBZ	dBZ	Base Reflectivity	10 Level/37.5 km
072	REF	dBZ	dBZ	Base Reflectivity	10 Level/38.0 km
073	REF	dBZ	dBZ	Base Reflectivity	10 Level/38.5 km
074	REF	dBZ	dBZ	Base Reflectivity	10 Level/39.0 km
075	REF	dBZ	dBZ	Base Reflectivity	10 Level/39.5 km
076	REF	dBZ	dBZ	Base Reflectivity	10 Level/40.0 km
077	REF	dBZ	dBZ	Base Reflectivity	10 Level/40.5 km
078	REF	dBZ	dBZ	Base Reflectivity	10 Level/41.0 km
079	REF	dBZ	dBZ	Base Reflectivity	10 Level/41.5 km
080	REF	dBZ	dBZ	Base Reflectivity	10 Level/42.0 km
081	REF	dBZ	dBZ	Base Reflectivity	10 Level/42.5 km
082	REF	dBZ	dBZ	Base Reflectivity	10 Level/43.0 km
083	REF	dBZ	dBZ	Base Reflectivity	10 Level/43.5 km
084	REF	dBZ	dBZ	Base Reflectivity	10 Level/44.0 km
085	REF	dBZ	dBZ	Base Reflectivity	10 Level/44.5 km
086	REF	dBZ	dBZ	Base Reflectivity	10 Level/45.0 km
087	REF	dBZ	dBZ	Base Reflectivity	10 Level/45.5 km
088	REF	dBZ	dBZ	Base Reflectivity	10 Level/46.0 km
089	REF	dBZ	dBZ	Base Reflectivity	10 Level/46.5 km
090	REF	dBZ	dBZ	Base Reflectivity	10 Level/47.0 km
091	REF	dBZ	dBZ	Base Reflectivity	10 Level/47.5 km
092	REF	dBZ	dBZ	Base Reflectivity	10 Level/48.0 km
093	REF	dBZ	dBZ	Base Reflectivity	10 Level/48.5 km
094	REF	dBZ	dBZ	Base Reflectivity	10 Level/49.0 km
095	REF	dBZ	dBZ	Base Reflectivity	10 Level/49.5 km
096	REF	dBZ	dBZ	Base Reflectivity	10 Level/50.0 km
097	REF	dBZ	dBZ	Base Reflectivity	10 Level/50.5 km
098	REF	dBZ	dBZ	Base Reflectivity	10 Level/51.0 km
099	REF	dBZ	dBZ	Base Reflectivity	10 Level/51.5 km
100	REF	dBZ	dBZ	Base Reflectivity	10 Level/52.0 km

- RPG creates products on scan by scan basis
- Use Reflectivity, Radial Velocity, Spectrum Width, and dual-pol data streams
- Base products: Products that depict base data streams in most direct, meteorological manner
- Derived products: All products that aren't base products (e.g., CZ, DVIL)
- KDP treated as a base product since it's best for meteorological interpretation

[Click to view system diagram](#)

### Notes:

Based on operator input, the RPG generates products on a volume scan by volume scan basis. The RPG creates base products (Base Reflectivity, Base Radial Velocity, and Base Spectrum Width) at all elevations of the current VCP directly from the base data received from the RDA (i.e., Level II data). Likewise, three elevation-based products created from the dual-polarization base data stream (i.e., Differential Reflectivity, Correlation Coefficient, and Specific Differential Phase) are also considered to be base products. The RPG then produces derived products using these base data as input.

In general, any product that depicts the base data streams from the RDA are considered base products (i.e., namely, the six products mentioned above). Any product other than those that provide a direct depiction of the Level II data are considered a derived product. Composite Reflectivity is a good example of a derived product. The Composite Reflectivity product algorithm computes the maximum reflectivity at each grid box for all elevation angles and composites them into a single product. Other examples of derived products include:

- the Digital Vertically Integrated Liquid (VIL) product,
- the various Precipitation Processing Subsystem (PPS) and Dual-Pol Quantitative Precipitation Estimation (QPE) accumulation products, and
- the Tornadoic Vortex Signature (TVS) product.

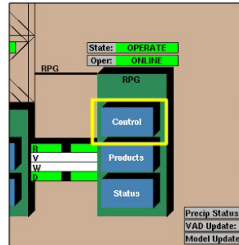
NOTE: Specific Differential Phase (KDP) is technically not a direct representation of the base data stream, but is the base data with a range derivative applied. However, KDP is considered a base product (even though some radar meteorologists argue that it is technically a derived product) because it is the most direct way to analyze this data stream in a meteorologically relevant manner. In all subsequent training in the Radar & Applications Course, KDP will be treated as a base product.



## RPG Control

### RPG Control

- RPG Human Computer Interface (HCI) controls the RPG
- RPG HCI controls how products are generated & distributed
- Examples include:
  - 8-hour performance check
  - Wideband & product distribution comms
  - Initiating a RPG reboot



[Click to view system diagram](#)

### Notes:

The RPG Human Computer Interface (HCI) at the MSCF controls the RPG. During a regular shift, a NWS forecaster may need to access the RPG HCI and change how products are generated or distributed for many reasons. Examples of RPG control tasks include:

- Manually starting the 8 hour performance check,
- Wideband and product distribution communications control, and
- Initiating a reboot of the RPG.

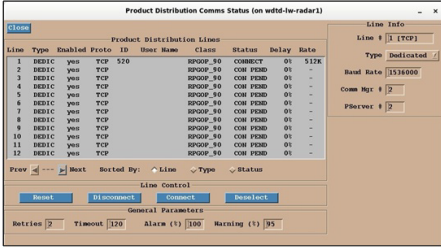
NOTE: The RPG HCI can also be displayed at the RPG KVM and Monitor Interface, which is similar to the MSCF terminal. However, most NWS staff will not need to access the RPG KVM and Monitor Interface.

## Product Distribution

### Product Distribution

Archive Level II

Archive Level III



Product Distribution Comms Status (on wfd0-1w-radar1)

Line	Type	Enabled	Proto	ID	User Name	Class	Status	Delay	Rate
1	DEDIC	yes	TCP	520		SP00F_90	CONNECT	01	512K
2	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
3	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
4	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
5	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
6	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
7	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
8	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
9	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
10	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
11	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-
12	DEDIC	yes	TCP			SP00F_90	CON PENDING	01	-

Line Info: Line # 3 [TCP], Type Undefined, Band Rate 1536000, Comm Hz 2, Filterwz 2

Line Control: Reconnect, Disconnect, Disconnect

General Parameters: Retries 2, Timeout 120, Alarm (1) 300, Warning (1) 95

- Sometimes referred to as “Narrowband” communications
- RPG distributes base data (Level II) and standard products (Level III) to a variety of users

[Click to view system diagram](#)

### Notes:

**Main Slide:** The RPG distributes the products it generates to a variety of users. The product distribution lines are sometimes referred to as narrowband communications because they once had significantly less bandwidth than the wideband communications between the RDA and RPG. This lesson provides more details on these transmission lines in later sections on the Product Distribution Communications and the Users Systems section. Use the buttons to the left of the image to learn more about the different data distributed to users by the RPG.

## Archive Level II (Slide Layer)

**Product Distribution**

Archive Level II

Archive Level III

**Base Data Flow to Archive II Clients**

```
graph LR; RDA[RDA] --> RPG[RPG]; RPG --> Clients[Archive II Clients];
```

- Each RPG makes base data available in real-time to outside users
- Base data also sent to NCEI for archiving

[Click to view system diagram](#)

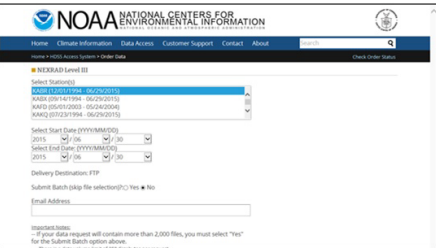
**Archive Level II:** The WSR-88D network includes 122 NWS Radar Product Generators (RPGs) in the Contiguous United States (CONUS), 25 Department of Defense (DoD) RPGs, and 12 Federal Aviation Administration (FAA) RPGs. Each of these RPGs have a separate system - included with its hardware and software - that makes the base data (i.e., Archive Level II data) from the signal processor available in real-time to outside users. This system, the Archive II Data Distribution System, provides a real-time stream of base data from any WSR-88D. These outside users include other government agencies, private companies, universities and research organizations. This system also transmits these data to the National Center for Environmental Information (NCEI) for archiving purposes.

## Archive Level III (Slide Layer)

### Product Distribution

Archive Level II

Archive Level III



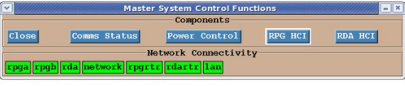
- Standardized set of products made available to NCEI for archiving
- These products also made available in real-time via RPCCDS

[Click to view system diagram](#)

**Archive Level III:** Archive Level III data are a specific set of products which are generated each volume scan. Each RPG distributes the Archive Level III set of products to the NCEI. This process, which is part of the Radar Product Central Collection/Distribution Service (RPCCDS), also makes these products available to other users besides NCEI.

## Master System Control Function

### Master System Control Function



- MSCF includes hardware and software allowing radar operators to interface with RDA & RPG
- RPG primarily HCI used by radar operators to perform system tasks
- RDA HCI primarily used by electronics technicians for various tasks

[Click to view system diagram](#)

### Notes:

The MSCF includes the hardware and software for operators to control the WSR-88D system and interface with the RPG and RDA through the RPG and RDA HCIs.

The RPG HCI is commonly used by operators for a variety of system tasks, such as:


- Changing a VCP or
- Editing adaptable parameters.

Some of these tasks, such as changing VCPs, can also be done at the AWIPS workstation. The RDA HCI is primarily used by Electronics Technicians (ETs or EI Techs) to perform a variety of maintenance tasks.

## The RDA HCI

### The RDA HCI

- Tasks performed at RDA HCI:
  - Power transfers
  - Generating static bypass maps
  - Coordinating with ETs for off-line maintenance



[Click to view system diagram](#)

### Notes:

Any non-maintenance change in the operational state at the RDA must be initiated at the RDA HCI. Examples of these operational state changes include:

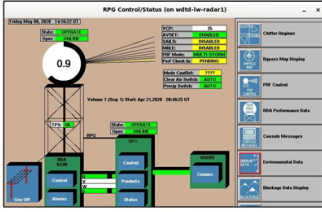
- Power transfers,
- Generating Bypass Maps for clutter suppression, and
- Coordinating with EI Techs for off-line maintenance.

The RDA HCI provides the EI Tech with extensive maintenance analysis tools to determine the overall health of the system. There are a number of diagnostic tools available to determine which maintenance tasks may be needed and if a trip to the RDA itself is necessary.

## The RPG HCI

### The RPG HCI

- RDA
- Data Quality
- Status Monitoring
- Free Text Message
- Product Distribution



• Tasks performed at the RPG HCI include:

- Optimizing data quality
- RPG status monitoring
- Generating Free Text Messages
- Controlling product distribution comms

[Click to view system diagram](#)

### Notes:

**Main Slide:** The RPG HCI directly controls the operation and performance of the RPG. Examples include:

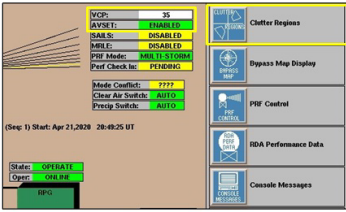
- Optimizing data quality,
- Status monitoring,
- Generating Free Text Messages, and
- Controlling Product Distribution Communications.

The RPG HCI also allows for some changes at the RDA, usually coordinated with your EI Tech.

## RDA (Slide Layer)

**The RPG HCI**

- RDA
- Data Quality
- Status Monitoring
- Free Text Message
- Product Distribution



The screenshot displays the RPG HCI interface. On the left, there is a sidebar with five radio buttons: RDA (selected), Data Quality, Status Monitoring, Free Text Message, and Product Distribution. The main area is divided into several sections. The top left section shows system parameters: VCP: 35, AVSET: ENABLED, SAR: DISABLED, NRE: DISABLED, PWF Mode: SAR, 11, ST, 0002, and Pref Check In: PENDING. Below this, there is a 'Mode Conflict' section with values 7777, Clear All Settings, and Press Refresh. A timestamp '(Step 1) Start: Apr 21, 2020 20:49:25 UT' is shown. At the bottom left, there are status indicators for 'State: OPERATE' and 'Oper: ONLINE'. The right side of the interface features a vertical menu with icons and labels: Clutter Regions, Bypass Map Display, PWF Control, RDA Performance Data, and Console Messages.

- Examples of RDA changes performed at RPG HCI:
  - Changing VCPs
  - Toggling AVSET on & off
  - Downloading clutter suppression region files

[Click to view system diagram](#)

**RDA:** Some tasks that affect operations are initiated at the RPG HCI, but are executed at the RDA. Examples are:

- Changing VCPs,
- Manually enabling/disabling AVSET, and
- Downloading clutter suppression region files.

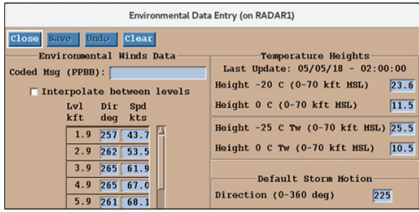
in recent years, common tasks performed at the RPG HCI have been coded where they can also be initiated from a GUI at the AWIPS workstation. Examples of these tasks include changing VCPs and toggling AVSET on and off.



## Data Quality (Slide Layer)

**The RPG HCI**

- RDA
- Data Quality
- Status Monitoring
- Free Text Message
- Product Distribution



The screenshot shows the 'Environmental Data Entry (on RADAR)' window. It includes a 'Close' button, 'Save', 'Info', and 'Clear' buttons. The main area is divided into 'Environmental Winds Data' and 'Temperature Heights'. The 'Environmental Winds Data' section has a 'Coded Msg (PPBB):' field and an 'Interpolate between levels' checkbox. Below this is a table with columns 'Lvl kft', 'Dir deg', and 'Spd kts'. The 'Temperature Heights' section has a 'Last Update: 05/05/18 - 02:00:00' and a list of height-based temperature readings. The 'Default Storm Motion' section has a 'Direction (0-360 deg)' field.

Lvl kft	Dir deg	Spd kts
1.9	257	43.7
2.9	262	53.5
3.9	265	61.9
4.9	265	67.6
5.9	261	68.1

- The RPG HCI has tools to optimize data quality
- Examples include:
  - Using the appropriate clutter suppression
  - Selecting the optimal VCP
  - Using the appropriate adaptable parameters

[Click to view system diagram](#)

**Data Quality:** The data that each WSR-88D site generates are available to numerous users for interpretation and decision making. Poor data quality can make product interpretation difficult and could impact critical decisions. The RPG HCI offers NWS forecasters the tools to generate the best quality data possible with current system engineering and design. Examples of data quality problems mitigated using the RPG HCI include:

- Downloading the appropriate clutter suppression region file
- Selecting the optimal VCP for the current weather situation and
- Monitoring and editing adaptable parameters or environmental wind data, when needed.

## Status Monitoring (Slide Layer)

**The RPG HCI**

- RDA
- Data Quality
- Status Monitoring
- Free Text Message
- Product Distribution

Precip Status:	ACCUM
VAD Update:	ON
Model Update:	ON
CMID:	ENABLED
Load Shed:	NORMAL
H Delta dBZ:	8.17 dB
V Delta dBZ:	-8.18 dB

- The RPG HCI provides comprehensive status info on the RDA
- Routine monitoring helps maintain quality products

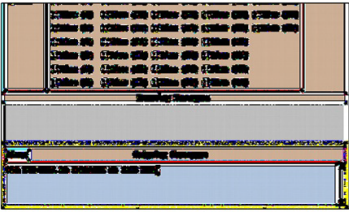
[Click to view system diagram](#)

**Status Monitoring:** The RPG HCI offers comprehensive status information on the condition of the RDA, the RPG, and certain users. This information must be monitored frequently to ensure proper system operation so that all users continue to receive quality products.

## Free Text Message (Slide Layer)

### The RPG HCI

- RDA
- Data Quality
- Status Monitoring
- Free Text Message
- Product Distribution



- FTM = Free Text Message
- Used to notify users of certain tasks being performed at the RPG HCI, including:
  - RPG reboot
  - Resetting comms hardware

[Click to view system diagram](#)

**Free Text Message:** Certain tasks performed at the RPG HCI require notifying users of that RPG's products that their access will be impacted. The Console Messages button is an efficient tool for composing Free Text Messages and informing users of any upcoming interruptions in their products. Examples include:

- An upcoming RPG reboot and
- Resetting the communications hardware at the RPG.

For more information on how Free Text Messages fit into system operations and responsibilities, please read:

- Federal Meteorological Handbook No. 11 (FMH-11), Part A (and
- The tri-agency Memorandum of Agreement for the Interagency Operation of the WSR-88D.

## Product Distribution (Slide Layer)

**The RPG HCI**

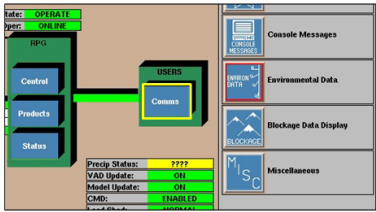
RDA

Data Quality

Status Monitoring

Free Text Message

Product Distribution



The screenshot shows a graphical user interface for the RPG HCI. On the left, there is a vertical menu with five radio buttons: RDA, Data Quality, Status Monitoring, Free Text Message, and Product Distribution (which is selected). The main area contains a system diagram with a central 'USERS' box connected to an 'RPG' box. The 'RPG' box has sub-sections for 'Control', 'Products', and 'Status'. The 'USERS' box has a 'Comms' sub-section. Below the diagram, there is a status table:

Presip Status:	????
VAD Update:	ON
Model Update:	ON
CMDB:	ENABLED

On the right side of the interface, there are several panels: 'Console Messages', 'Environmental Data', 'Blockage Data Display', and 'Miscellaneous'. A 'Resources' panel is also visible at the bottom right.

- Products distributed over various transmission lines
- Principal users have dedicated or dial-up comms
- All other users use dial-up connections
- Both are controlled at RPG HCI


[Click to view system diagram](#)

**Product Distribution:** As products are generated by the RPG, they are sent to the various users over product distribution lines of various transmission rates. These communication lines for principal users (such as the NWS) can be either dedicated or dial-up connections. Offices that control a specific RPG have dedicated connections; All others have dial-up connections. These communication lines are controlled at the RPG HCI.

## Product Distribution Comms

### Product Distribution Comms

- Primary AWIPS
- Supplemental AWIPS
- Dial-Up Access



- Products transmitted through various lines
- NWS sites: High speed primary connections
- DoD/FAA sites: Dedicated private IP connection
- NWS dial-up access: Transmit through AWIPS WAN

[Click to view system diagram](#)

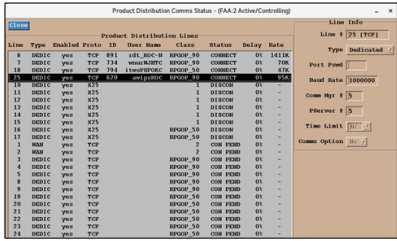
### Notes:

**Main Slide:** As mentioned in the previous section, products generated by the RPG are sent to users over various transmission lines. For most NWS CONUS offices with a dedicated connection to an RPG, the primary connections are high speed lines (AWIPS Local Area Network to NWS RPG LAN connections). For DoD and FAA users (or NWS users of DoD and FAA RPGs), the dedicated connection utilizes a private IP connection. NWS dial-up access initiates at the AWIPS workstation and transmits through the AWIPS Wide Area Network (WAN). Many additional users access the WSR-88D base data (i.e., Archive Level II) and national product list (i.e., Archive Level III) via other distribution methods.

## Primary AWIPS (Slide Layer)

### Product Distribution Comms

- Primary AWIPS
- Supplemental AWIPS
- Dial-Up Access



Line	Type	Enabled	Proto	ID	Unit Name	Class	Status	Delay	Rate
8	SDSIC	yes	YCP	891	cdl_BOC-W	EPDOP-30	CONNECT	01	1411K
7	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
14	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K
15	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
16	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K
17	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
18	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K
19	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
20	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K
21	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
22	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K
23	SDSIC	yes	YCP	714	mem-BDPT	EPDOP-30	CONNECT	01	70K
24	SDSIC	yes	YCP	714	tuapargate	EPDOP-30	CONNECT	01	27K

Line Info: Line # 25 (TOP)  
Type: Dedicated  
Port Pool: [ ]  
Band Rate: 1000000  
Comm #1: [ ]  
Priority: [ ]  
Time Limit: [ ]  
Comm Option: [ ]

- Each office should have one or more primary connections
- Connections generally fast, load shedding rare
- Load shedding more common at OCONUS & DoD sites

[Click to view system diagram](#)

**Primary AWIPS:** Each office should have one or more primary AWIPS connection to a WSR-88D. Your location and type of radar will determine the speed of your primary connection.


Most CONUS NWS offices have a primary AWIPS connection to an NWS radar. These connections are generally fast (approximately 1 Mbps), and load shedding should occur rarely on this connection. CONUS offices with a primary AWIPS connection to a DoD radar will have throughput speeds about half that of a NWS radar. Even with this slower connection, load shedding issues are rare unless there is widespread precipitation and you are using VCP 12 or 212.

Outside of CONUS offices, load shedding is a more likely issue. NWS offices in Alaska and Hawaii both have primary AWIPS connections with typical speeds one-quarter to one-third of that at CONUS sites. Both of these regions can expect load shedding in faster VCPs (e.g., 12 or 212), particularly if there is widespread precipitation. Guam's primary AWIPS connection, unlike those in Alaska or Hawaii, is similar to that of a CONUS site.

## Supplemental AWIPS (Slide Layer)

### Product Distribution Comms

- Primary AWIPS
- Supplemental AWIPS
- Dial-Up Access



- Supplemental connections to RPG also available
- Significantly slower than primary connection
- RPS lists for supplemental sites should be shorter, focusing on routinely needed products

[Click to view system diagram](#)

**Supplemental AWIPS:** In addition to their primary AWIPS connections, many NWS offices can utilize supplemental AWIPS connections to surrounding radars that may provide a better view of precipitation in their county warning area. These connections are significantly slower than their primary AWIPS connections (i.e., 64-200 Kbps vs 1 Mbps). Products on supplemental AWIPS connections are requested via a Routine Product Set (or RPS) list the same way as with the primary AWIPS connections.


When using RPS lists to request data on supplemental AWIPS connections, offices need to use more care in identifying which products they want to request. RPS lists on these connections should focus on the products forecasters routinely need to perform their duties to prevent load shedding on these slower connections, especially when using faster VCPs during active weather.

NOTE: During office backup support, NWS offices can access a neighboring radar using a different, temporary AWIPS connection that may provide faster throughput speeds depending on your location. However, this connection shares bandwidth with other lines and may not always be your best throughput option. In general, it's best to monitor product availability and adjust your RPS list accordingly during active weather to ensure your AWIPS performs optimally.

## Dial-Up Access (Slide Layer)

### Product Distribution Comms

- Primary AWIPS
- Supplemental AWIPS
- Dial-Up Access



- OTR = One-Time Request
- RMR = Radar Multiple Request
- Load shedding possible due to single line used
- Only request products you are likely to use

[Click to view system diagram](#)

**Dial-Up Access:** Another way NWS offices can request data from a nearby RPG is by submitting a One-Time Request (OTR) or a Radar Multiple Request (RMR) via dial-up access. These requests share a dedicated connection (with a throughput of 128 Kbps), so requests from multiple offices (or even large requests from a single office) can cause load shedding issues. Load shedding from a particular RPG is most likely when service backup operations are ongoing, since OTRs and RMRs share bandwidth with the service backup connection.

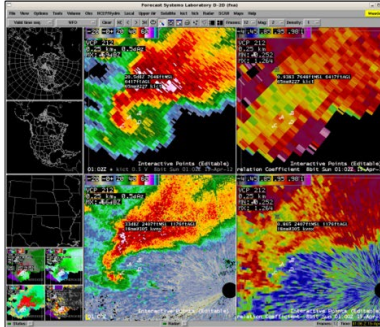
The best way to avoid load shedding on these connections is to avoid requesting products with OTRs or RMRs that your office staff are not likely to use.



## User Systems

### User Systems

- Users fall into two general groups:
  - Principal users
  - Other users



[Click to view system diagram](#)

### Notes:

Numerous organizations and individuals use WSR-88D products. We categorize them into two groups based on how they access the data: Principal Users and Other Users. In general, Principal Users (i.e., users among the NWS, FAA, and DoD) have a dedicated and/or dial up connection to a RPG. The remaining users in the NEXRAD Agencies and other users in government, private companies, and academia are referred to as "Other Users."

## Principal Users

### Principal Users

- Governmental agencies that own the WSR-88D
- Displays systems include:
  - NWS (AWIPS-II)
  - DoD (Gibson Ridge)
  - FAA (WARP & ITWS)



[Click to view system diagram](#)

### Notes:

Principal users are members of the governmental agencies which own the WSR-88D. Principal users access RPGs directly through either dedicated or dial-up connections. Each principal user employs different display systems. For instance,

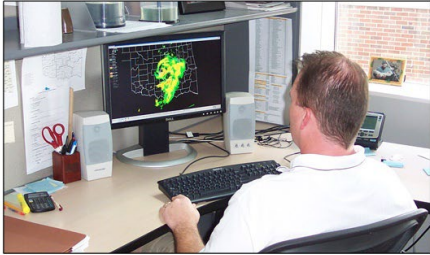
- The NWS uses the Advanced Weather Interactive Processing System (AWIPS) - II,
- The DoD uses the Gibson Ridge (GR) Analyst software (Levels II and III), and
- The FAA has a variety of display systems, including the Weather and Radar Processor (WARP) and the Integrated Terminal Weather System (ITWS).

Software and hardware development with these display systems are coordinated with those of the WSR-88D, enabling new WSR-88D products to be displayable on their respective display systems once created by the RPG.

## Other Users

### Other Users

- Archive II Clients
- RPCCDS Users



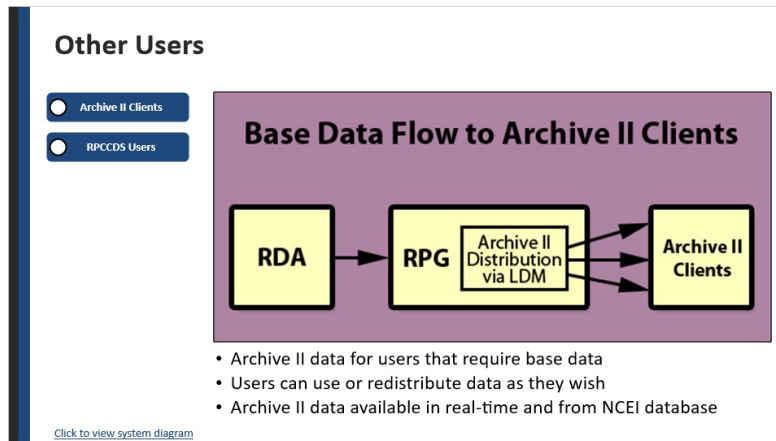
- Other user: Any user who isn't a principal user
- Access WSR-88D base data & products in various ways

[Click to view system diagram](#)

### Notes:

**Main Slide:** Other users have access to WSR-88D base data, as well as a predefined set of base and derived products from the RPG. Access for these users outside the three agencies can be achieved in a variety of ways depending on their needs. Use the buttons on the left to learn more about how these users access radar data.

## Archive II Clients (Slide Layer)



**Archive II Clients:** For users that require base data (i.e., Archive Level II), the Archive II Data Distribution System provides real-time access to this data stream. These users, or Archive II Clients, have no restrictions on the use or redistribution of the base data. In addition to real-time usage, the Archive Level II data are also transferred to archives at the NCEI. The NCEI makes the archived data available for general use to research organizations and other users interested in past events.

## RPCCDS Users (Slide Layer)

### Other Users

- Archive II Clients
- RPCCDS Users



- RPCCDS = Radar Product Central Collection/Distribution Service
- RPCCDS users get national list of products (Level III)

[Click to view system diagram](#)

**RPCCDS Users:** Other users wanting to view WSR-88D products can access a predefined set of real-time products via the Radar Product Central Collection/Distribution Service (RPCCDS). The AWIPS data server sends these products through a dedicated connection to the Network Control Facility's servers at Silver Spring, MD. From there, the data can be accessed by users in real-time via:

- The NWS Ridge web site,
- Paid access to dedicated connections for private companies,
- Third party smartphone applications,
- Free access to a File Transfer Protocol (FTP) server, or
- Other access from many other private sector and university sites.

Outside users can also access these products (i.e., Archive Level III data) via the NCEI archives for past events.

## AWIPS - II

### AWIPS - II

- AWIPS Narrowband Comms
- AWIPS & RPCCDS
- AWIPS Workstation



- AWIPS = Advanced Weather Interactive Processing System
- Hardware & software used by NWS

[Click to view system diagram](#)

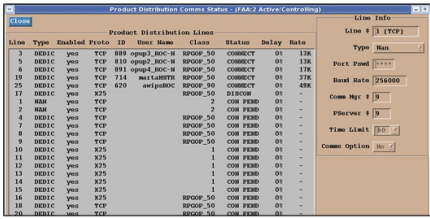
### Notes:

**Main Slide:** The NWS hardware and software used to acquire, process, and store the products received from the RPG is called AWIPS, which is primarily located in a computer equipment room in the NWS office. AWIPS operators request, display, and manipulate WSR-88D products at an AWIPS workstation in their local operations area. The NWS currently uses the second generation of AWIPS, commonly called AWIPS - II.

## AWIPS Narrowband Comms (Slide Layer)

### AWIPS - II

- AWIPS Narrowband Comms
- AWIPS & RPCCDS
- AWIPS Workstation



Line	Type	Enabled	Proto	ID	User Name	Class	Status	Delay	Rate
3	DEDIC	yes	TCP	880	opnet1_RDC-H	RPDOR_50	CONNECT	01	13K
5	DEDIC	yes	TCP	810	opnet1_RDC-H	RPDOR_50	CONNECT	01	13K
6	DEDIC	yes	TCP	891	opnet1_RDC-H	RPDOR_50	CONNECT	01	17K
19	DEDIC	yes	TCP	710	macLARENS	RPDOR_50	CONNECT	01	17K
25	DEDIC	yes	TCP	620	awipsnetC	RPDOR_50	CONNECT	01	49K
12	DEDIC	yes	R25			RPDOR_50	DISCON	01	
1	MAN	yes	TCP			2	COW FEED	01	-
2	MAN	yes	TCP			2	COW FEED	01	-
4	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-
7	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-
8	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-
9	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-
10	DEDIC	yes	R25			1	COW FEED	01	-
11	DEDIC	yes	R25			1	COW FEED	01	-
12	DEDIC	yes	R25			1	COW FEED	01	-
13	DEDIC	yes	R25			1	COW FEED	01	-
14	DEDIC	yes	R25			1	COW FEED	01	-
15	DEDIC	yes	R25			1	COW FEED	01	-
16	DEDIC	yes	R25			1	COW FEED	01	-
18	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-
20	DEDIC	yes	TCP			RPDOR_50	COW FEED	01	-

- AWIPS w/co-located RPGs have dedicated LAN connections
- All AWIPS can use RPS List, OTRs, & RMRs for non-dedicated sites
- AWIPS can send data & commands to RPG, too

[Click to view system diagram](#)

**AWIPS Narrowband Comms:** All AWIPS sites with co-located RPGs have a dedicated TCP/IP connection from the AWIPS LAN to the RPG LAN. For NWS sites with MSCF control of DoD or FAA radars, AWIPS connects to those RPGs by a Private IP connection. All AWIPS sites can also access data from non-dedicated RPGs using RPS Lists, as well as either the One-Time Request or Radar Multiple Request processes through the AWIPS WAN.

AWIPS both receives and sends data to dedicated RPGs through the Product Distribution (sometimes called Narrowband) Communications lines. AWIPS data servers transfer Rapid Refresh (RAP) model data to the RPG. In doing so, users can automate the computation of RPG algorithm inputs that require environmental data (e.g., the Hail Detection Algorithm and the Environmental Wind Table). AWIPS users can also send commands to the RPG that mimic tasks typically performed at the RPG HCI, such as:

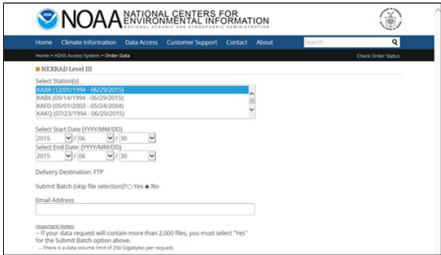
- Enabling AVSET,
- Changing VCPs, and
- Choosing to enable SAILS (and how many SAILS tilts to include).

This capability makes it easier for the radar operator to maintain data quality during operations of a time sensitive nature (such as warning operations).

## AWIPS & RPCCDS (Slide Layer)

### AWIPS - II

- AWIPS Narrowband Comms
- AWIPS & RPCCDS
- AWIPS Workstation



The screenshot shows the NOAA National Centers for Environmental Information website. The main content area is titled "NEXRAD Level III" and features a "Select Station(s)" dropdown menu with options: "NEXRAD (01/01/2014 - 06/29/2015)", "NOMA (01/14/1994 - 06/29/2015)", "NWS (05/01/2003 - 05/31/2004)", and "NWSQ (07/23/1994 - 06/29/2015)". Below the dropdown are fields for "Select Start Date (YYYYMMDD)", "Select End Date (YYYYMMDD)", and "Delivery Destination: FTP". There is also a checkbox for "Submit Batch (skip file selection)": Yes No and an "Email Address" field. A note at the bottom states: "If your data request will contain more than 2,000 files, you must select 'Yes' for the Submit Batch option above. There is no maximum limit on file size per request."

- AWIPS plays an important role in disseminating Level III products to other users
- AWIPS WAN transfers data to NCF, other users

[Click to view system diagram](#)


**AWIPS & RPCCDS:** In addition to making RPG products available to NWS WFO staff, the AWIPS also plays an important part in disseminating WSR-88D products out to other organizations. Each RPG sends Archive Level III products via the AWIPS WAN to the NCF in Silver Spring, MD. From there, the Archive Level III data are made available to other users through the RPCCDS.



## AWIPS Workstation (Slide Layer)

**AWIPS - II**

- AWIPS Narrowband Comms
- AWIPS & RPCCDS
- AWIPS Workstation



- AWIPS uses Linux workstations
- CAVE = Common AWIPS Visualization Environment
- CAVE displays radar and other data types on common background

[Click to view system diagram](#)

**AWIPS Workstation:** AWIPS uses Linux-based workstations to display the radar image products and alphanumeric data. The primary application used for radar data display and analysis is the Common AWIPS Visualization Environment (CAVE). CAVE can display:

- All of the products on the Product Generation Table,
- Products requested through the One-Time Request and Radar Multiple Request processes, and
- Alerts from the dedicated RPGs.

The power of the AWIPS workstation is its ability to display radar and all other meteorological data on a common map background.

## **Conclusion**

### **Conclusion**

We identified:

- 6 components of the WSR-88D & their functions
- Several key functions of the WSR-88D & which components (or sub-components) perform them
- Where components & sub-components fit into the system as a whole
- Systems or data streams where users may visualize data from the WSR-88D
- Interfaces (RPG HCI, RDA HCI, or AWIPS) where certain tasks can be performed

### **Notes:**

During this lesson, we identified the following items. We discussed the six components (and the various sub-components) that make up the WSR-88D. We, also, mentioned their functions. Likewise, we highlighted certain key functions of the WSR-88D system and which parts of the system perform them. So, hopefully you feel comfortable relating the components of the system to the system's functions, and vice versa. We discussed how each of the components and sub-components fit into the system as a whole, too. We identified the systems and data streams that users may use to visualize radar data. We also discussed the different interfaces where radar operators might interact with the WSR-88D system in order to control the data it outputs.

With this information in mind, please proceed to the next slide to start the quiz.

## ***Lesson Completion***

A screenshot of a lesson completion screen. The screen is divided into two sections by a diagonal blue line. The left section is white and contains the following text: 'Lesson Completion', 'You have successfully completed the lesson!', 'Questions???:', a bulleted list of two email addresses: 'Andrew.C.Wood@noaa.gov' and 'nws.rachelp.wdtd@noaa.gov', and 'Use the Exit button to close the lesson & record completion'. The right section is a solid grey color.

**Lesson Completion**

You have successfully completed the lesson!

Questions???:

- [Andrew.C.Wood@noaa.gov](mailto:Andrew.C.Wood@noaa.gov)
- [nws.rachelp.wdtd@noaa.gov](mailto:nws.rachelp.wdtd@noaa.gov)

Use the Exit button to close the lesson & record completion

### **Notes:**

Congratulations on completing the lesson! You are now ready to move on to the rest of the Radar & Applications Course. If you are taking this lesson in the Commerce Learning Center, please make sure to use the Exit button in the player to close this window and record your completion.