LESSON 1 ABOUT CHPS

The Community Hydrologic Prediction System (CHPS) was designed to provide efficient operations at RFCs, opportunities for incorporating external models, and an infrastructure for coordination with external partners.

This lesson describes the transition to CHPS and describes the responsibilities of different RFC focal points. By the end of this lesson, you should be able to:

- Explain the transition from NWSRFS to CHPS.
- Outline the history of CHPS implementation.
- Describe different RFC focal points and their duties.
- List CHPS resources.

1.2 TRANSITION

The National Weather Service River Forecast System (NWSRFS), a suite of Office of Hydrology-developed river forecasting software, was used by River Forecast Centers since 1985.

The NWS looked for a service-oriented architecture and commercial, off-the-shelf approach to river forecast capabilities in the early 2000's.

The NWS selected Deltares, a company based in the Netherlands, in 2005 to facilitate the transition. The transition was completed in early 2012.

Beginning in 2014, CHPS hardware began using virtual servers. The hardware refresh required only three physical servers per office instead of nine.

According to the NWS CHPS page, CHPS is many things, including an implementation strategy, a software architecture, and a business model. The new system more easily accommodates advances in hydrologic science within the public and academic communities.

Note: For the scope of this course, CHPS refers to river forecasting system.

The National Weather Service Training Center (NWSTC) is providing River Forecast Centers (RFC) training on configuration, simulations, and system management, and concepts for optimal use of the system.

References: *Deltares Wiki* | *OHD-CHPS Page*

1.3 HISTORY

2002 – In the early 2000's, the NWS began looking for modernization options for NWSRFS.

2005 – Deltares (then known as Delft), demonstrated the Delft-FEWS (Flood Early Warning System) software at NWS headquarters.

2006 – A CHPS Acceleration Team (CAT), consisting of representatives from OHD, CNRFC, NCRFC, NWRFC, and ABRFC, formed to work with Deltares, Riverside Technology Inc., and RS Information Systems to explore the potential of modernizing NWSRFS rather than replacing it.

2007 – A prototype, CHPS FEWS Pilot, was demonstrated at NWRFC. In December 2007, software implemented at the CAT RFCs and demonstrated at NERFC. New software capabilities included ability to modify time series (MODS) and the addition of the SNOW-17 model.

2008 – NERFC joined the CAT and NCRFC participated in the second phase of implementation.

2009 – In early 2009, the CAT RFCs began migrating to CHPS. The second wave of RFCs, the CAT-II offices, began planning their implementation strategy. By early 2010, the CAT RFCs completely migrated to CHPS.

2011 – Migration continued with the last RFCs employing the system by the end of 2011 and early 2012.

2014 - CHPS hardware upgrade decreased the number of servers to three by using virtual servers. Prior to 2014, CHPS ran on nine servers.

1.4 ROLES

Responsibilities and roles at RFCs vary, so do the specific tasks for each focal point. Some offices may have a focal point for each task, or a team.

Some of the common CHPS focal point roles include:

- **Configuration Focal Point:** Manages and create configuration files in CHPS.
- **System Manager:** Oversees the system performance and overall administration.
- **Simulation Focal Point:** Supervises simulations and maintains files and software.
- **Data Focal Point:** Administers the data flow and creation of new data.
- **Graphics Generator Template Focal Point:** Builds and edits Graphics Generator templates to produce customized hydrologic output.

Division of Tasks

Many CHPS processes can be complicated and involve a large number of files and/or steps. You may want to divide the tasks within your RFC. Many offices find it helpful to assign people to specific tasks in order to prevent duplicating each other's work.

Communication Skills

Make an effort to maintain clear lines of communication. This includes steps such as adding comment lines when changing code or creating an administration log. Work with other members of the staff to develop a documentation strategy.

Program Management Tip: Whether working alone or with a team, creating a log will help you recall what changes have been made to the hardware, software, and files in your office's CHPS.

Support Services

The Development and Operations Hydrologist (DOH) at your office can provide more guidance on the needs in the CHPS program at your RFC. The Information Technology Officer (ITO) and Service Coordination Hydrologist (SCH) are also great resources.

1.5 RESOURCES

View the following resources for additional information about CHPS, RFC topics, or for support with CHPS-related issues.

The RFC Support page contains information on CHPS, hydro manuals, RFS manuals, and other resources.

The Deltares Wiki is the host site for Deltares training, documentation, and manuals (login required).

Visit the Office of Hydrologic Development (OHD) page for information on software, programs, working groups, and the strategic plan for the hydrologic community.

Stay informed with the CHPS page, which not only describes the Community Hydrologic Prediction System, but has links to implementation activities and minutes of meetings.

Join the discussion! Subscribe to CHPS and hydrology forums on the NWS Listserv (login required).

Report problems to the RFC support group by submitting trouble tickets in FogBugz. The site also has a wiki component with documentation on various aspects of CHPS (login required).

LESSON 2 HARDWARE

Whether using the system or working with people who do, to fully understand the system, you need to know what pieces are involved and how they connect to make CHPS function.

This lesson describes the hardware associated with CHPS. By the end of this lesson, you should be able to:

- List the major components of the CHPS system.
- Describe how each piece of hardware communicates with the others.
- List the purposes of each server.
- Compare the features of the Operator Client (OC) and Stand Alone (SA).

2.2 COMPONENTS

The servers and hardware in CHPS communicate to make the system function as a whole.

Introduction - The CHPS system has three physical servers; REP1, REP2, and REP3.

Each REP has three virtual servers, CHPS 1/2/3, CHPS 4/5/6, or CHPS 7/8/9.

Each virtual server plays a role in the operations of CHPS.

AWIPS Workstations - The connection point to each of the physical servers and the shared drive containing the Flood Early Warning System (FEWS), the forecasting software of CHPS.

Users - Forecasters run instances of the Operator Client (OC) on the workstation to create forecast output.

Forecasters use the Stand Alone (SA) instance to run simulations or testing.

CHPS focal points use the workstations to access each of the CHPS servers and complete maintenance tasks.

Master Controller - Home of the application server and the brain of CHPS. Housed on CHPS 1, 4, and 7.

MC Function - The MC delegates tasks, relays messages, and monitors the system. The MC functions require several applications – System Monitor, FS Listener, OC Listener, Task Manager, and Synchronizer applications.

Database Server – Host of the Central Database, which contains all of the imported CHPS data. The database servers are on CHPS 2, 5, and 8.

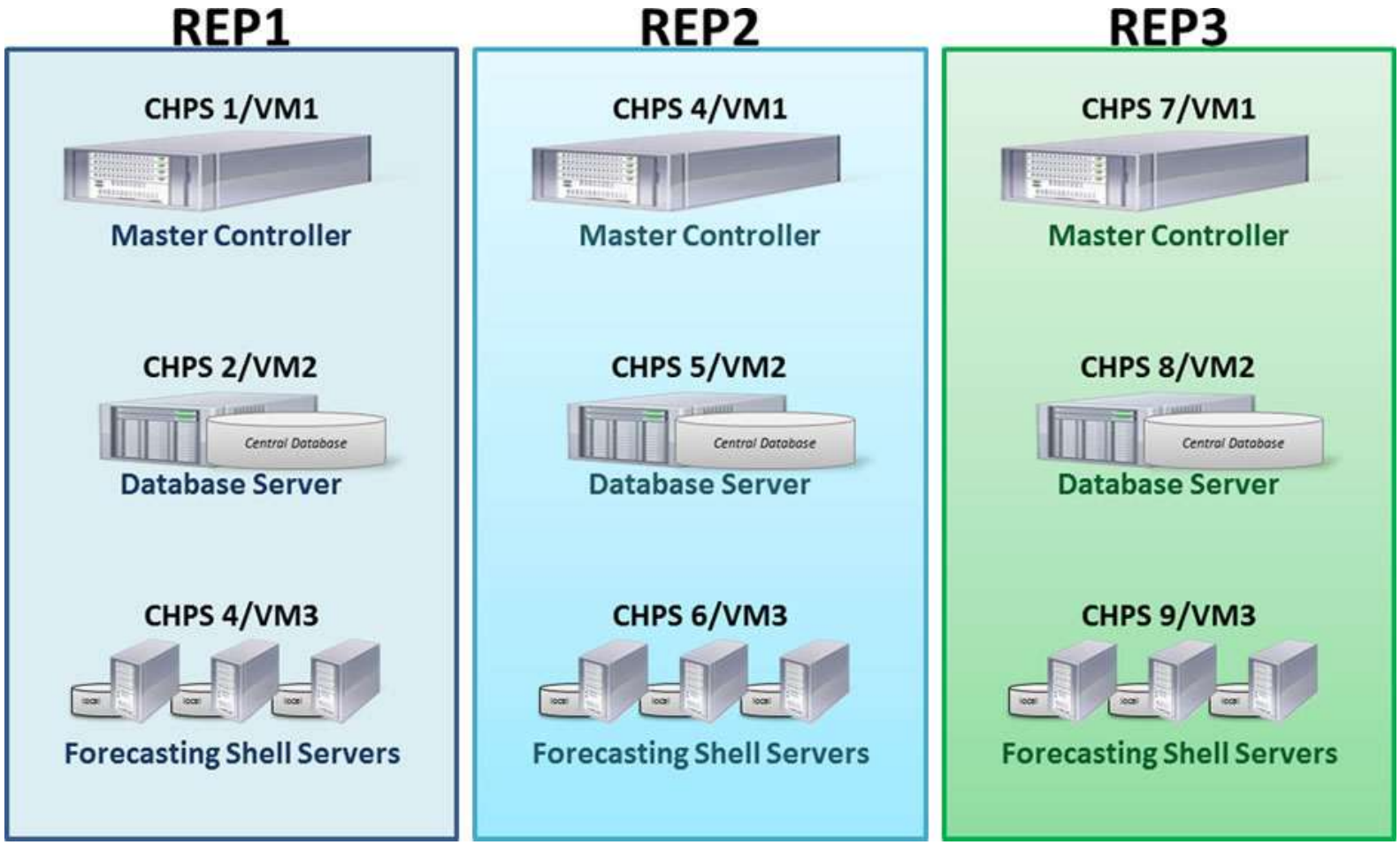
Central Database – The database server hosts the Central Database. All CHPS data is stored in the Central Database. The database uses PostgresQL database management software.

FSS Servers – Houses the Forecasting Shell Servers (FSS), which run CHPS tasks. The FSSs are hosts on CHPS 3, 6, and 9.

2.3 CHPS SERVERS

The functions of CHPS are performed by three servers called **River Ensemble Processors** (REPs). The servers are designated as REP1, REP2, and REP3.

Each REP houses three **virtual servers**. The virtual servers (or virtual machines) are designated always referred to as VM1, 2, or 3, regardless of which physical server it resides.



2.4 OC AND SA

Slide Text

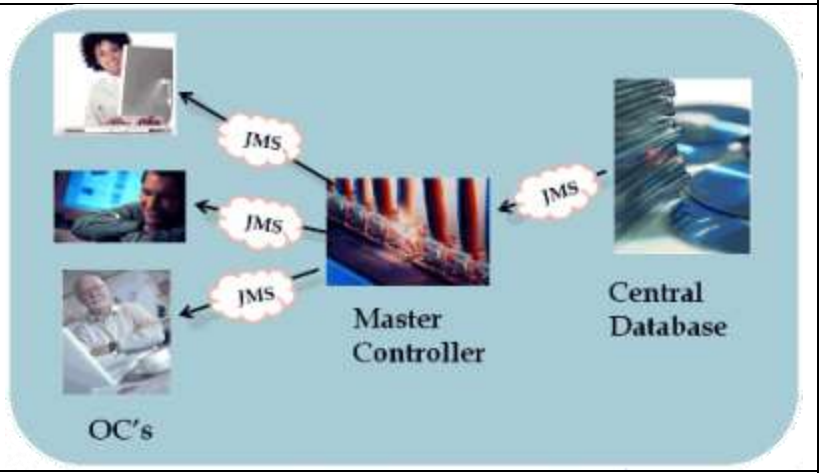
CHPS: A Tale of Two Modes; OC vs. SA

Two Modes

- The two modes were created to enable RFCs to test and validate changes to the CHPS system without affecting the operational system.
- The operational version is called the Operator Client or OC.
- The Stand Alone (SA) is the test bed version of the system.

Operator Client

- The OC communicates with the Master Controller, passing data back and forth with the Central Database.
- Each forecaster has an individual instance of the OC with a local datastore.



Stand Alone

- The Stand Alone system for CHPS can be thought of as an "all-in-one".
- Use the SA to make changes to the CHPS settings to test them. This way, operations will not be interrupted by the changes.
- Each user with an OC account has the ability to use CHPS in SA mode.
- Unlike the OC, the SA is NOT connected to the Master Controller.
- Instead, the SA runs off a local datastore and file system.
- Each user with an OC account has the ability to use CHPS in SA mode.

LESSON 3 SOFTWARE

The software incorporated into CHPS includes several interfaces and tools to make forecasting and system administration much easier.

This lesson provides information on the software associated with CHPS. By the end of this lesson, you should be able to:

- Describe how the Java software components work together.
- List system interfaces and uses.
- Describe the uses for tools associated with CHPS.
- List several CHPS processes.

3.2 SOFTWARE

Much of the CHPS system runs Java software. The presentation below describes the role of each piece of Java software.

Introduction: CHPS uses commercial off-the-shelf (COTS) software rather than NWS-developed software. The software installed in CHPS is consistent among offices, and additional support is available online. By knowing what software is used in CHPS and how it functions, System Managers can more easily identify the source of problems and resolve them quicker. Much of the CHPS system runs Java software. This makes it easy for the applications to not only communicate with the server, but also with each other.

JBoss is the application server. It provides infrastructure for JMS. Since it is a Java-based server, it functions well when deploying and communicating with the rest of the Java software in CHPS.

JDBC – The Java Database Connectivity (JDBC) driver allows Java programs to access database management systems connected to it (how DbVis accesses FirebirdSQL and PostgresQL databases).

JMS – The Java Messaging System (JMS) is a messaging service used in CHPS to transfer information from JBoss (CHPS1) to the Master Controller. It also connects the Master Controller to the FSS and the MC to the OC.

JRE – The Java Runtime Environment (JRE) software executes all of the Java programs. CHPS uses Java Runtime Standard Edition.

MCProxy is an application on each FSS that acts as an interface for the FSS can…

- accept task dispatch requests from the MC
- start a Forecasting Shell Server to honor the request
- respond to queries from the MC on the status of the FSS

Tomcat – Apache Tomcat software, running on a web server, builds the Administration Interface.

3.3 INTERFACES

IFD – The Interactive Forecast Display (IFD) is the forecasting interface for CHPS. The IFD panel and tab layout is customizable.

Workflow Navigator - The Workflow Navigator depicts the registered workflows and processing steps for a forecast area. The tool, accessed through the IFD, allows the user to search workflows and module instances and perform limited workflow editing.

Database Viewer – The Database Viewer, accessed through the IFD, allows the user to see the time series data stored in the database. Users can search for a particular time series or its related task run, parameters, and modules.

System Monitor – The System Monitor, accessed from the IFD, displays the status of the system. The type of information displayed in the SA differs from what is shown in the OC. Information could include log files, system status, and batch forecast information.

3.4 TOOLS

The CHPS interfaces provide many ways to monitor and use the system, but the system also has other external tools to make using and maintaining CHPS easier.

The **Configuration Manager** GUI allows the user to upload configurations to the Central Database. The configuration files are sent to the Central Database for distribution to local datastores and use in the forecast interface. The Configuration Manager features a tree structure for navigation through the configuration files.

The **Administration Interface** (also known as AI or the Admin Interface) is a web-based monitor for the health of the CHPS system. Not only is a status available for various components of the system, but scheduling and viewing log files can also be accomplished with this tool. The Administration Interface is also where workflows and tasks can be mapped to the FSSs so all of the tasks do not back up on one server.

DbVisualizer is a comprehensive search and query application. This tool also provides a tree structure for the databases as well as an SQL query tool. One of the most efficient functions of the tool is the ability to look at multiple databases of various types across the entire system.

Other tools may be found on your RFC's CHPS system and can include applications such as **XML editors** or data extraction tools.

3.5 PROCESSES

CHPS system efficiencies are controlled as part of the Deltares configuration and processes including Rolling Barrel, Amalgamate, MarkedRecordManager, and Synchronization.

Rolling Barrel

The Rolling Barrel task makes a new data store (a database, containing data imported into CHPS, stored on the local file system) copy, which is stored in a temporary directory. The system then deletes the old data store, and moves the newly created temporary data store to its place.

The Rolling Barrel process ensures information is not stored in the system longer than it needs to be. This prevents the system from becoming overpopulated with data.

Amalgamate

The Amalgamate task takes multiple small pieces of data and combines it into one single record and therefore one single entry in the database. This also frees up space in the system and the data store.

MarkedRecordManager

The MarkedRecordManager task, another removal task, deletes records scheduled to be deleted (but only if they are scheduled).

Synchronization

The Synchronization task is responsible for synchronizing one MC to another. This task is useful because it prevents having to create information two or three times between the server clusters. It also helps provide a failover solution.

References: Deltares Wiki – Master Controller Tasks | Amalgamate

LESSON 4 FILE STRUCTURE

While there are a large number of files in the CHPS system, navigating them can be very easy if you know the file structure and hierarchy.

This lesson provides information on the data format and directory structure of CHPS. By the end of this lesson, you should be able to:

- Describe the CHPS directory structure.
- Locate commonly used directories.
- List the formats in which CHPS data is stored.
- Describe the hierarchy of CHPS configuration files.
- Explain the use of XML in CHPS.

4.2 DIRECTORIES

The directory structure of CHPS makes it easy to locate files.

Unless you have a CHPS focal point duty, it is unlikely you will venture much further than the chps_share directory.

Configuration files for components only found on the virtual server housing the components. Recall, CHPS has three physical servers, REPs 1, 2, and 3, which contain virtual CHPS 1 through 9.

Files used across multiple servers are connected through a mounted directory called CHPS Share (chps_share).

Example: Since the JBoss software is located on CHPS 1 and is operated through that server, all of the configuration files are located on CHPS 1.

DbVisualizer can be accessed using any of the CHPS servers. The configuration files and the program itself are accessed through the CHPS share directory.

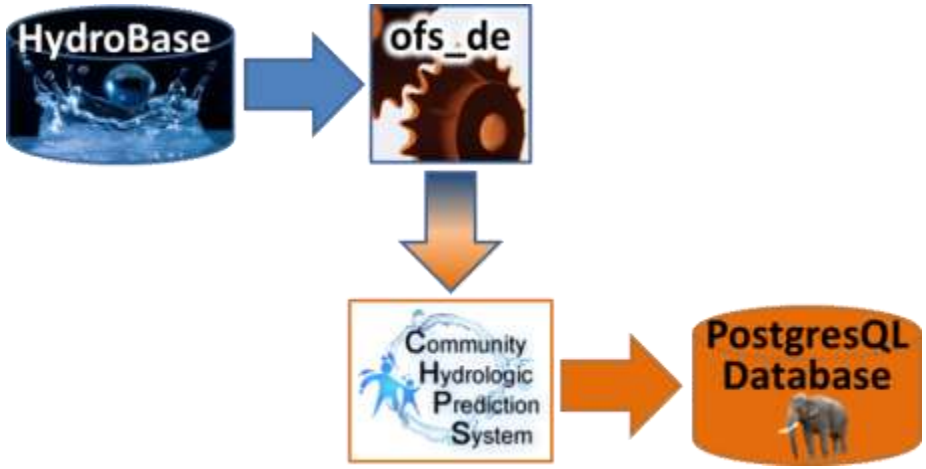
The image on the right is a snapshot of the contents of the chps_share directory:

Note: This directory contains the instances of the OC and SA. The directory also contains external applications and tools, and the Install directory containing all of the patches and builds.

Depending on your role at the RFC, you may need to explore the directory structure in more depth.

4.3 DATA STORAGE

CHPS stores observed and forecast data. Here is a bit of background on how the data is stored.



The Integrated Hydrologic Forecast System Database (also known as HydroBase) stores observed data. The observed data includes river stage, temperature, and precipitation data.

A script called ofs_de extracts Postgres data from HydroBase.

The script passes the data to CHPS.

A scheduled task posts the data to the CHPS PostgresQL database.

CHPS stores all forecast data as time series. CHPS time series are stored as **Binary Large Objects** (BLOBs). BLOBS are not in a human-readable format. Use the Data Viewer to see the data.

4.4 CONFIGURATION

The CHPS base configuration directory contains several important subdirectories. The following list contains brief descriptions of the folders located in this directory. These files make up the entire configuration of CHPS and how information is processed and displayed to a forecaster.

Directory Name	/Config Directory Contents
ColdStates	Zip files of the forecast's initial conditions used for system spin up.
DisplayConfigFiles	Definitions of the layout of user displays, including "what if" scenarios, grid display, etc.
IconFiles	Icons used in the main map display and button bar.
IdMapFiles	Definitions of mapping ID's and parameters between external sources and ID's and parameters defined in CHPS
MapLayerFiles	Map layers (shape files) used in the main map and spatial displays.
ModuleConfigFiles	Definition of modules used to process data.
ModuleDataSetFiles	Zipped files containing datasets for modules used by the forecasting system.
ModuleParFiles	Definitions of the module parameters stored in CHPS.
RegionConfigFiles	Definitions for the regional configuration, including all locations and parameters.
SystemConfigFiles	Definitions for the system, including the plug-ins available to the system. The layout of the Time Series display and main GUI are also defined.
UnitConversionFiles	Definitions of the unit conversions between external sources and units used in CHPS.
WorkflowFiles	Definitions of workflows, which run sequences of modules.

4.5 INTRODUCTION TO CHPS XML

The CHPS configuration files are in XML. **XML** stands for e**X**tensible**M**arkup **L**anguage. XML is a markup language much like HTML. It does **not** replace HTML. It was designed to *carry* (act as a container for) data, not to *display* data. In other words, XML does not DO anything without software to send, receive, or display it.

XML Schema

XML is the most common tool for data transmissions between applications. The XML language (itself) has no predefined tags; however, each XML configuration in CHPS adheres to a XML Schema Definition (XSD).

XML Schema Definition (XSD) language is the current standard schema language for all XML documents and data. The XML Schema definition language (XSD) enables programmers to define the structure and data types for XML documents.

XML Advantages

There are several benefits to XML. XML is…

Extensible - programmers can create their own tags.

Compatible - XML is widely used, making information exchange with other agencies and academia easier. It is an internal standard maintained by an independent standards committee, the World Wide Web Consortium (W3C).

Inexpensive - XML does not cost anything to use. It can be written with a simple text editor or one of many free XML authoring tools.

Easy to Use - XML is "human legible" and reasonably clear. Descriptive element tags identify content.

Platform/Software Independent - XML is both platform and software independent. Most browsers and text editors also support it.

Separates Structure from Function - XML simply houses information. It relies on separate style sheets for appearance settings. This allows for greater manipulation of data and elements.

A basic understanding of HTML and JavaScript is helpful prior to working with XML.

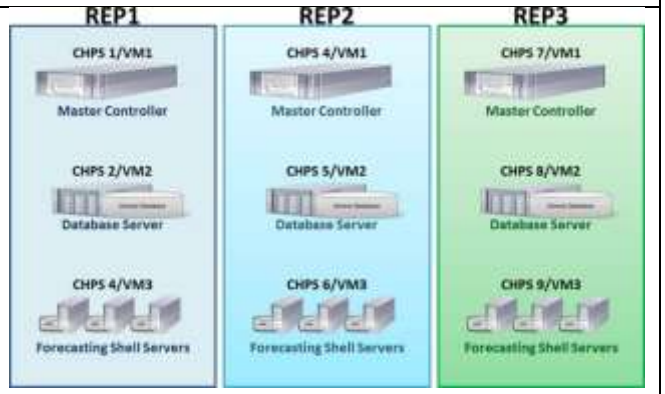
COURSE SUMMARY

About CHPS

- **Early 2000's** - NWS began looking for a SOA/COTS approach to replace NWSRFS.
- **2005** - NWS selected Deltares to facilitate the transition.
- **2007** - A CHPS prototype was demonstrated in April. By December, the software was being used at the first wave of offices, called CAT-I RFCs.
- **2009** - CAT-I offices began migrating to CHPS.
- **Early 2012** - All RFCs were migrated to CHPS.
- Focal point roles include, but are not limited to:
  - **Configuration Focal Point:** Manages and creates configuration files in CHPS.
  - **System Manager:** Oversees the system performance and overall administration.
  - **Simulation Focal Point:** Supervises simulations and maintains files and software.
  - **Data Focal Point:** Administers the data flow and creation of new data.

Hardware

- The **MC** delegates tasks, relays messages, and monitors the system.
- The database server hosts the **Central Database**.
- The **FSSs** execute tasks and model runs and have MC Proxy, a scaled down version of the Master Controller.
- The **Operator Client** (OC) is the live system and the **Stand Alone** (SA) is the test bed version of CHPS.
- **REP1** – Forecast operations
- **REP2** – Backup system, testbed for patches and builds
- **REP3** – Hydrologic development projects, testbed for patches and builds



Software

Java Software

- **JBoss**, the application server, provides the infrastructure for the **Java Messaging System** (JMS), the service used to transfer information from JBoss (CHPS1) to the Master Controller.
- **JDBC** driver allows the Java programs to access the database management system. The **Java Runtime Environment (JRE)** executes all of the Java programs.
- **MCProxy** accepts task requests from the MC, starts the FSS to honor the request, and responds to queries about the status of the FSSs.
- **Apache Tomcat** builds the Administration Interface.

CHPS Interfaces

- **Interactive Forecast Display (IFD)** - the forecasting interface for CHPS.
- **Workflow Navigator** - shows registered workflows and processing steps for the forecast area.
- **Database Viewer** - displays the time series stored in the database.
- **System Monitor** - displays the status of the system.

CHPS Tools

- **Configuration Manager (CM)** - allows the user to upload configurations to the Central Database.
- **Administration Interface (AI or Admin Interface)** - a web-based monitor for the health of the CHPS system.
- **DbVisualizer** - a database query application.

CHPS Processes

- **Rolling Barrel** - makes a new data store copy, deletes the old data store, and moves the newly created temporary data store to its place.
- **Amalgamate** - a task that takes multiple small pieces of data and combines it into one single record and therefore one single entry in the database.
- **MarkedRecordManager** - deletes records scheduled to be deleted (but only if they are scheduled).
- **Synchronization** - copies (synchronizes) the data to the MCs. This task prevents creating the information two or three times between the server clusters.

File Structure

- Configuration files for components only found on a single, virtual server are only located on that server.
- Files used across multiple servers are connected through a mounted drive called CHPS Share (chps_share).
- The CHPS base configuration directory contains several important subdirectories, including ColdStates, Config, Help, Icons, localDataStore, Map, and Models.

XML Advantages

- Programmers can create their own tags.
- Widely used, so exchanging information with other agencies and academia is easier.
- No cost to use XML, and there are many free XML authoring tools.
- Code is "human-legible" and reasonably clear.
- Platform and software independent and most browsers and text editors support it.

Congratulations. You reached the end of the course material!