Memorandum

To: Daivamani Sivasailam
From: Jinchul Park
Date: October 18, 2010
Re: MOVES Distributed Processing and Application Results (draft)

This memo is to document the application of distributed processing (DP) to MOVES with the goal of reducing runtime and DP time results against the results of the regular MOVES runs. I tested DP using two operating systems: Windows XP and Windows 7. I presented the DP application results using Windows XP at the September MOVES Task Force meeting. The memo discusses the results using Windows 7, which will be presented at the October meeting.

Distributed Processing: How It Works

MOVES is composed of two program modules: MOVES Master and Worker. A user 'can take advantage of DP by having the master and multiple worker computers on the same network 'point' to a drive and folder that is accessible to all the computers involved' to save computer runtime. The DP works as the following order: (1) one computer is set up as a Master and other computers are set up as Workers; (2) these Master and Worker computers share one work folder in a network drive; (3) the Master computer computes and sends work packets to a shared folder; and (4) Worker computers grab work packets from the shared folder, execute the assigned work, and send the computation results to the shared folder; and (5) the Master computer grabs the results from the folder, finalizes the emissions calculations, and stores the calculation results in its local drive as specified in the MOVES runspec. A configuration of Master and Work computers is illustrated as an example in Figure 1, in which one Master and three Worker computers are connected via local area network.
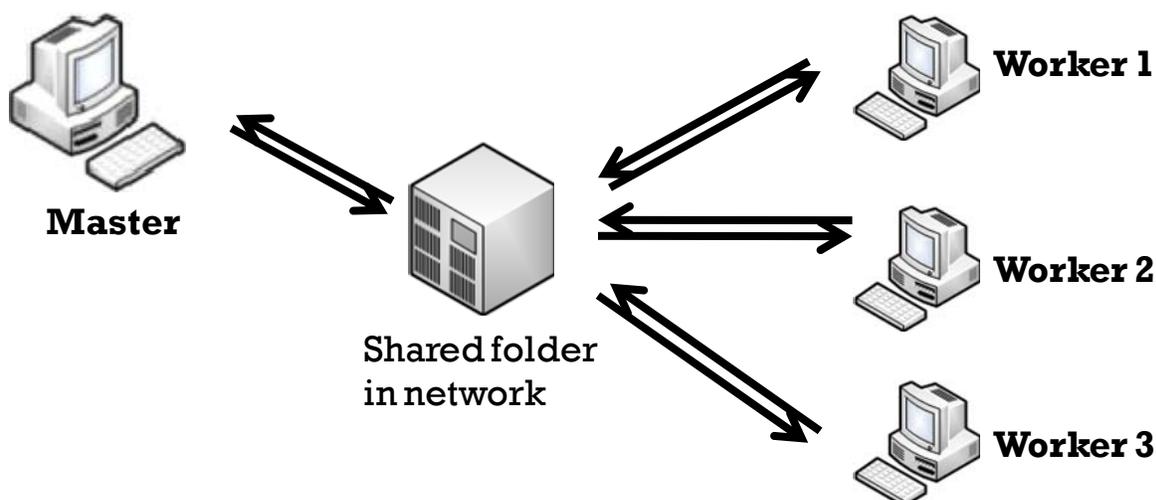

Figure 1. Design Example: Master & 3 Workers

Distributed Processing: How To Set up and Execute

Distributed processing can be set up and executed by taking the following steps:

A. Setup

Configure the MOVES setup files, so Master and Worker computers could share the same work folder such that:

Revise only the shared folder path in both 'MOVESConfiguration.txt' and 'WorkerConfiguration.txt' (These files could be found under C:\Program Files\MOVES20091221):

`sharedDistributedFolderPath = C:\Program Files\MOVES20091221\SharedWork`

as

`sharedDistributedFolderPath = I:\MOVES\DP_Testing\SharedWork`
(A user may define the folder name in a network drive)

In the second test one Master and Worker computers are directly connected by a network switch to avoid any interference from local area network traffic (see Figure 2).

1 Master
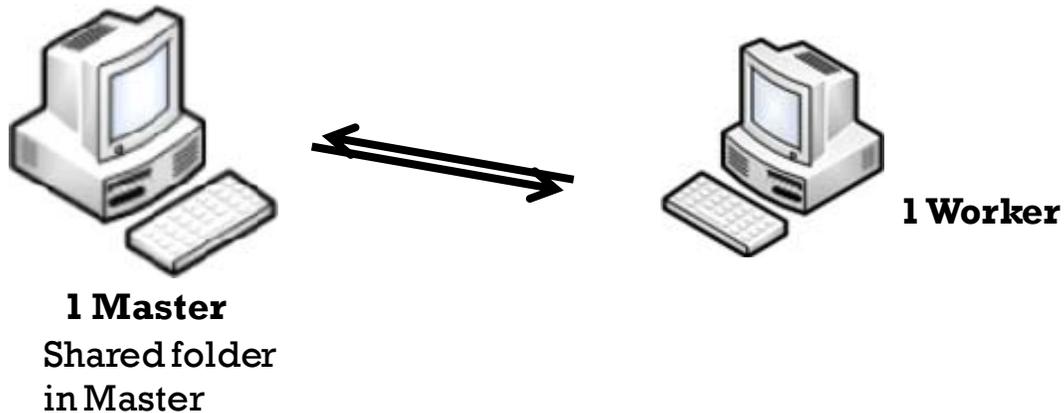Shared folder
in Master

1 Worker

Figure 2. DP Computer Setup in the second test: 1 Master & 1 Worker

B. Execution

- Step 1: Put all MRS file and input files under the Master computer.
- Step 2: Double-click the 'MOVES Worker' icon to start the MOVES Worker in worker computers

(You may see a DOS windows and a MOVES work status windows pop up at you). Do the same operation for all worker computers to make them stand-by.

- Step 3: In the Master computer, double-click the 'MOVES Master' icon to start MOVES GUI, and open the MRS file and specify all the necessary data and setup.
- Step 4: Execute the MRS file in MOVES GUI.
  (You may see that WORK IDs are created for the Master and Worker computers in the shared folder, and work packets exchanging among the Master and Worker computers)

Once the MOVES execution is finished, all the emissions results are stored in the output folder that a user defined, and the folder may be located under C:\MySQL\data in the Master computer.

Distributed Processing: Test Results

Two sets of DP test have been performed: a daily ozone run using Windows XP operating software results which were presented at the September MOVES Task Force meeting (see Table 1), and a daily ozone and annual runs using a 32-bit Windows 7 operating software. COG is transitioning to Windows 7 operating system, so that computers running on Windows 7 were used in the second DP test. COG's Office of Information Technology and Facility Management (ITFM) set up two Windows 7 laptop computers for DP tests in a way to avoid any interference from local area network traffic (Figure 2). Runtime results from the second run are shown in Table 2.

The first DP test result shows a 35% time saving for an ozone day run. The percent time saving is in line with the saving reported by Mohamed Khan, MDE. However, the second test shows no runtime improvements for either ozone day or annual runs (see Table 2). I found out that Windows 7 in the second DP test produced the almost same runtimes regardless of regular or DP runs. I think that DP does not seem to work in Windows 7. The MOVES manual or other background documents don't mention the DP performance of MOVES in Windows 7, so that I expect that EPA would provide more detailed guidance about DP application in Windows 7 and distribute a software patch in the future.

Table 1. The First Distributed Processing Runtime Comparisons: Regular Vs. DP Runs* (in minutes)

MOVES Model	Regular Run	DP - 2 Computers**	Time savings	% Savings
Ozone Day Runtime	31 min.	20 min.	11 min.	35%

*2005 Montgomery County data are used.
**Two computers were used for the DP test with the following specs such as:
Windows XP SP3; Intel Core 2 Duo CPU; 3.0GHZ clock speed; 3.48GB RAM

Table 2. The Second Distributed Processing Run Time Comparisons: Regular Vs. DP Runs* (in minutes)

MOVES Model	Analysis	Regular Run	DP - 2 Computers	Time savings
Inventory Approach	Ozone Day	38 min.	36 min.	2 min.
	Annual	289 min.	288 min.	1 min.

*2005 Montgomery County data are used.

**Two computers were used for the DP test with the following specs such as:
Intel Core Duo CPU T8100 2.1GHz; 2 Gig RAM; 32-bit Windows 7

Summary and Next Steps

Distributed processing (DP) is a useful technique for MOVES modelers to save runtimes. When multiple runs should be executed, this technique would help expedite MOVES modeling times. I tested DP in both Windows XP and Windows 7 environments, and could save runtimes only in Windows XP. I concluded that DP is not working in Windows 7 based on several DP test results. I expect that EPA would provide technical supports in DP application in the future as agencies opt for Windows 7 as the computer operation system.

EPA distributed MOVES2010a last August 2010, a revised version of MOVES2010. COG is testing this new MOVES model, and its performances in Windows 7 are not fully evaluated yet. COG is expected to perform regular and DP model runs using MOVES2010a.