SMDP-based Coordinated Virtual Machine Allocations in Cloud-fog Computing Systems

Abstract

- Heterogeneous computing powered by remote clouds and local fogs is a promising technology to improve the performance of user terminals in the Internet of Things (IoT).
- In this paper, two semi-Markov decision process (SMDP)-based coordinated virtual machine (VM) allocation methods are proposed to balance the tradeoff between the high cost of providing services by the remote cloud and the limited computing capacity of the local fog.
- We first present a model-based planning method in which it is necessary to train the state transition probabilities and the expected time intervals between adjacent decision epochs. To facilitate training them, the SMDP is degraded into a continuoustime Markov decision process (CTMDP) in which the service requests and ongoing service completions follow a continuoustime Markov chain (CTMC).

- The relative value iterative algorithm for the CTMDP is used to find an asymptotically optimal VM allocation policy. In addition, we also propose a model-free reinforcement learning method where an optimal coordinated VM allocation policy is approximated by learning from the states and rewards of feedback.
- The simulation results show that the performance of the model-free reinforcement learning method can converge to a level similar to that of the model-based planning method and outperform the greedy VM allocation method.

Existing system

- IoT terminal devices have limited computing capabilities due to the requirements of the deployment costs and the energy consumption. Therefore, a lot of applications in IoT terminal devices must be offloaded to remote clouds to be processed.
- because offloading applications to remote clouds needs multihop information transfer in wide area networks (WANs), which can cause problems for latency-sensitive applications such as real-time IoT analytics

Hardware requirement

- Processor - Pentium –III
- Speed - 1.1 Ghz
- RAM - 256 MB(min)
- Hard Disk - 20 GB
- Floppy Drive - 1.44 MB
- Key Board - Standard Windows Keyboard
- Mouse - Two or Three Button Mouse
- Monitor - SVGA

Software requirement

- Operating System - Windows 7/8
- Application Server - Tomcat 5.0
- Front End - JAVA
- IDE - NETBEANS 7.1
- Back-End - HEIDISQL 3.5

Proposed system

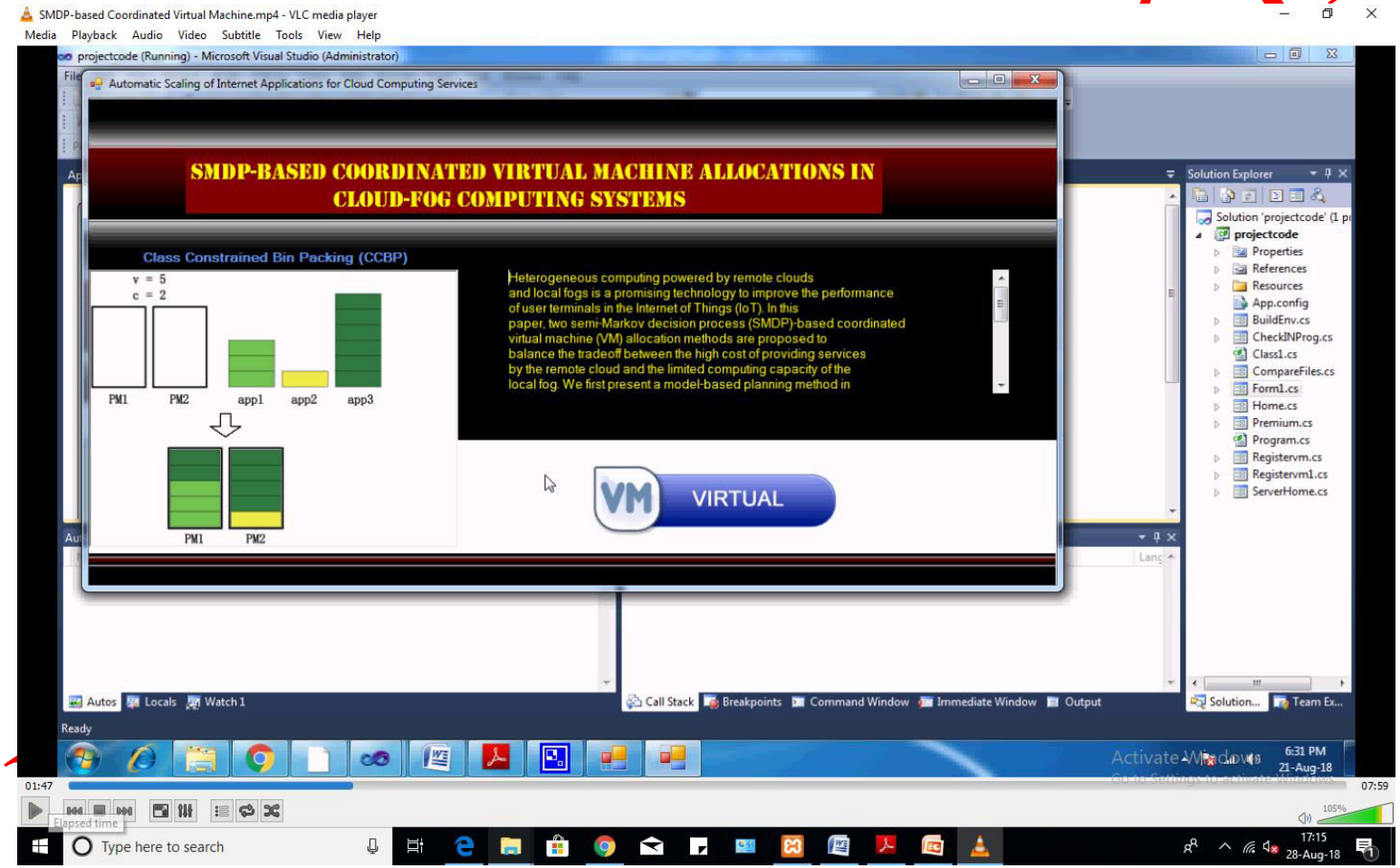
- In this paper, two semi-Markov decision process (SMDP)-based coordinated virtual machine (VM) allocation methods are proposed to balance the tradeoff between the high cost of providing services

  by the remote cloud and the limited computing capacity of the

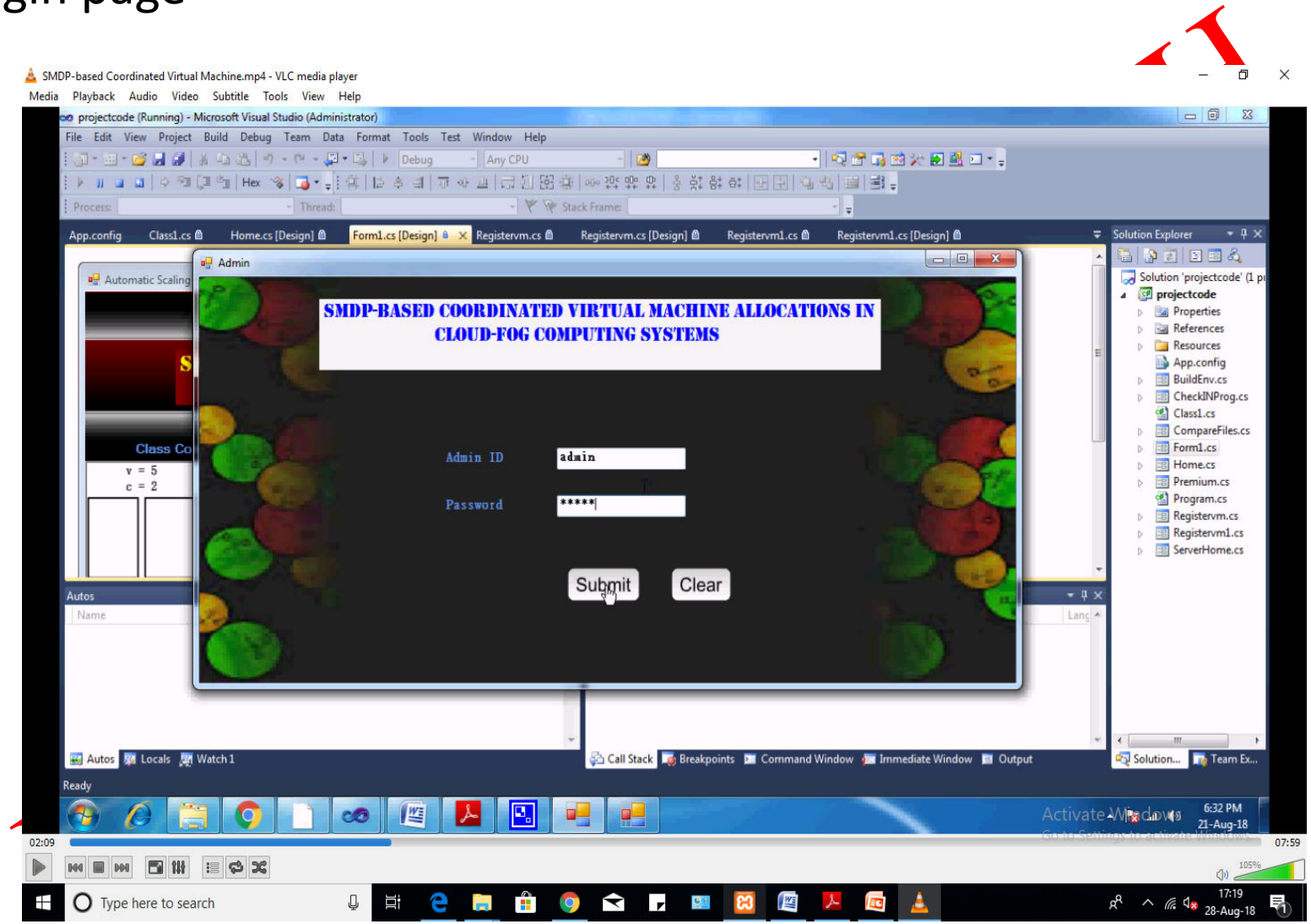
  local fog.
- We first present a model-based planning method in which it is necessary to train the state transition probabilities and the expected time intervals between adjacent decision epochs.
- To facilitate training them, the SMDP is degraded into a continuous time Markov decision process (CTMDP) in which the service requests and ongoing service completions follow a continuous time Markov chain (CTMC).

Screen short

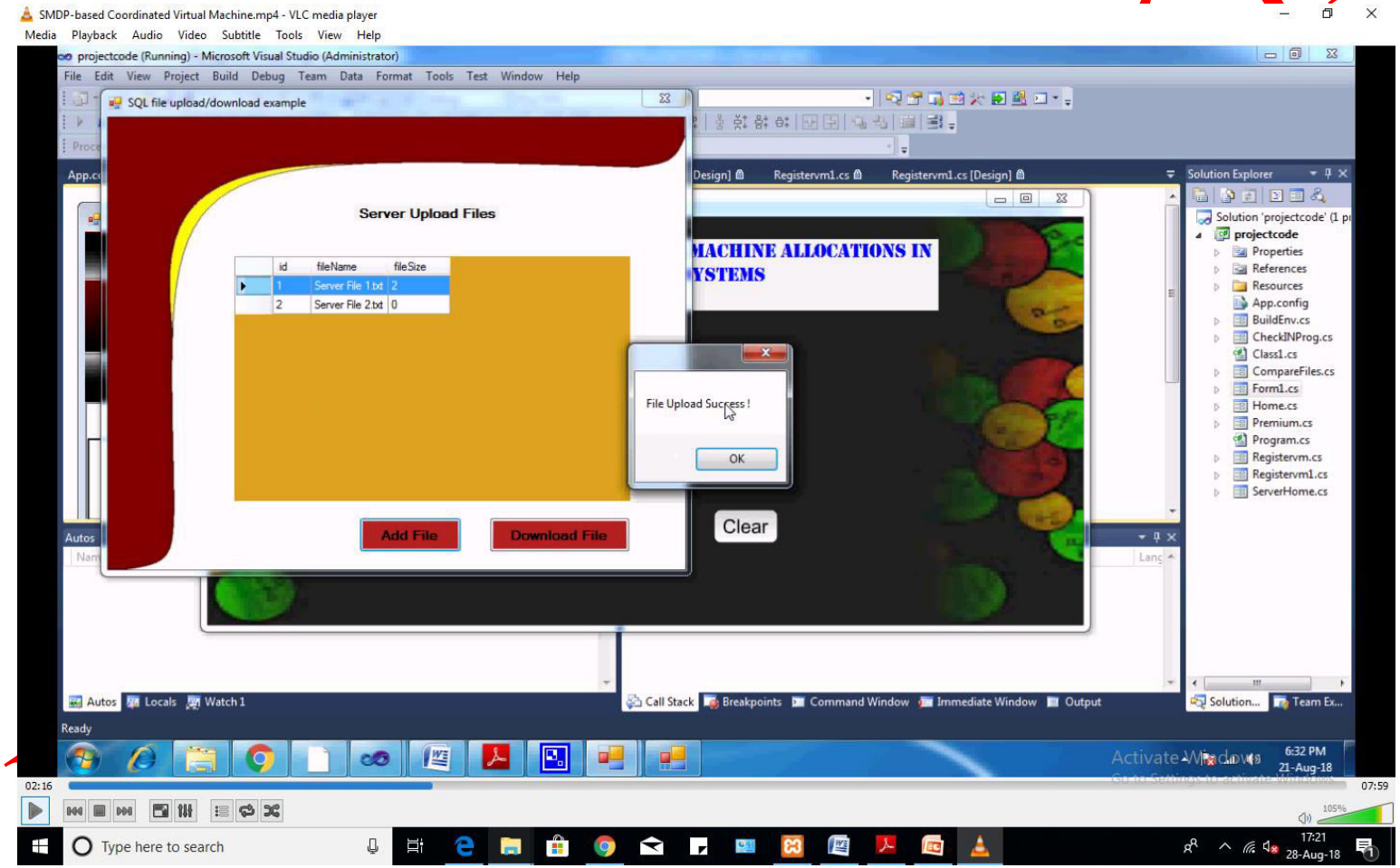
Admin page:



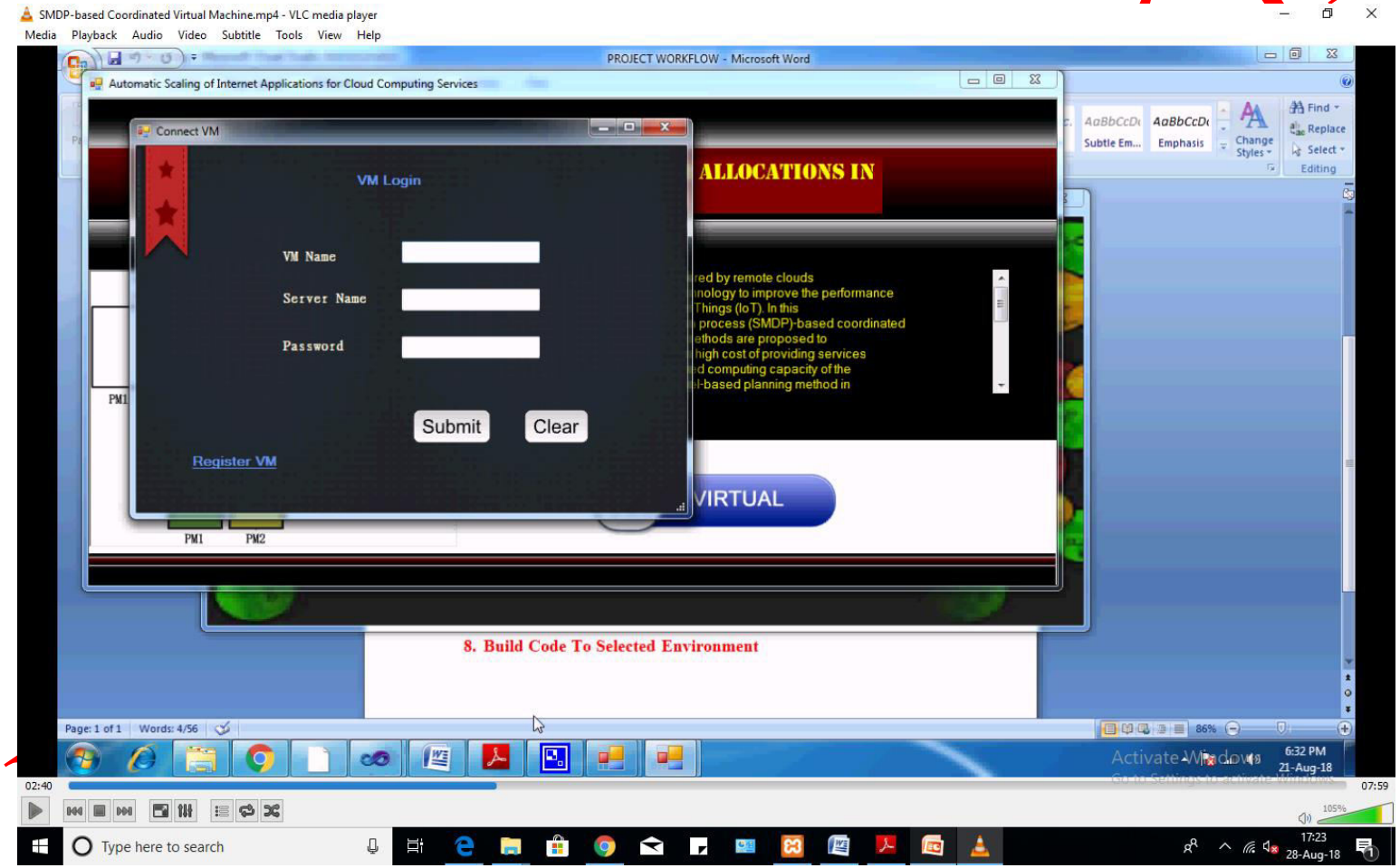
Login page


SMDP-based Coordinated Virtual Machine.mp4 - VLC media player
projectcode (Running) - Microsoft Visual Studio (Administrator)
Admin
SMDP-BASED COORDINATED VIRTUAL MACHINE ALLOCATIONS IN CLOUD-FOG COMPUTING SYSTEMS
Admin ID
admin
Password
Submit
Clear
Solution Explorer
projectcode
Properties
References
Resources
App.config
BuildEnv.cs
CheckINProg.cs
Class1.cs
CompareFiles.cs
Form1.cs
Home.cs
Premium.cs
Program.cs
Registervm.cs
Registervm1.cs
ServerHome.cs
Ready
Type here to search
17:19
28-Aug-18

Upload page


SMDP-based Coordinated Virtual Machine.mp4 - VLC media player
Media Playback Audio Video Subtitle Tools View Help
projectcode (Running) - Microsoft Visual Studio (Administrator)
File Edit View Project Build Debug Team Data Format Tools Test Window Help
SQL file upload/download example
Server Upload Files
id fileName fileSize
1 Server File 1.txt 2
2 Server File 2.txt 0
Add File
Download File
File Upload Success !
OK
Clear
Solution Explorer
projectcode
Properties
References
Resources
App.config
BuildEnv.cs
CheckINProg.cs
Class1.cs
CompareFiles.cs
Form1.cs
Home.cs
Premium.cs
Program.cs
Registervm.cs
Registervm1.cs
ServerHome.cs
Autos Locals Watch 1
Call Stack Breakpoints Command Window Immediate Window Output
Ready
6:32 PM 21-Aug-18
02:16
07:59
Type here to search
17:21 28-Aug-18

Connect vm


SMDP-based Coordinated Virtual Machine.mp4 - VLC media player
Media Playback Audio Video Subtitle Tools View Help
PROJECT WORKFLOW - Microsoft Word
Automatic Scaling of Internet Applications for Cloud Computing Services
Connect VM
VM Login
VM Name
Server Name
Password
Submit
Clear
Register VM
ALLOCATIONS IN
PM1
PM2
VIRTUAL
8. Build Code To Selected Environment
Page: 1 of 1
Words: 4/56
6:32 PM
21-Aug-18
02:40
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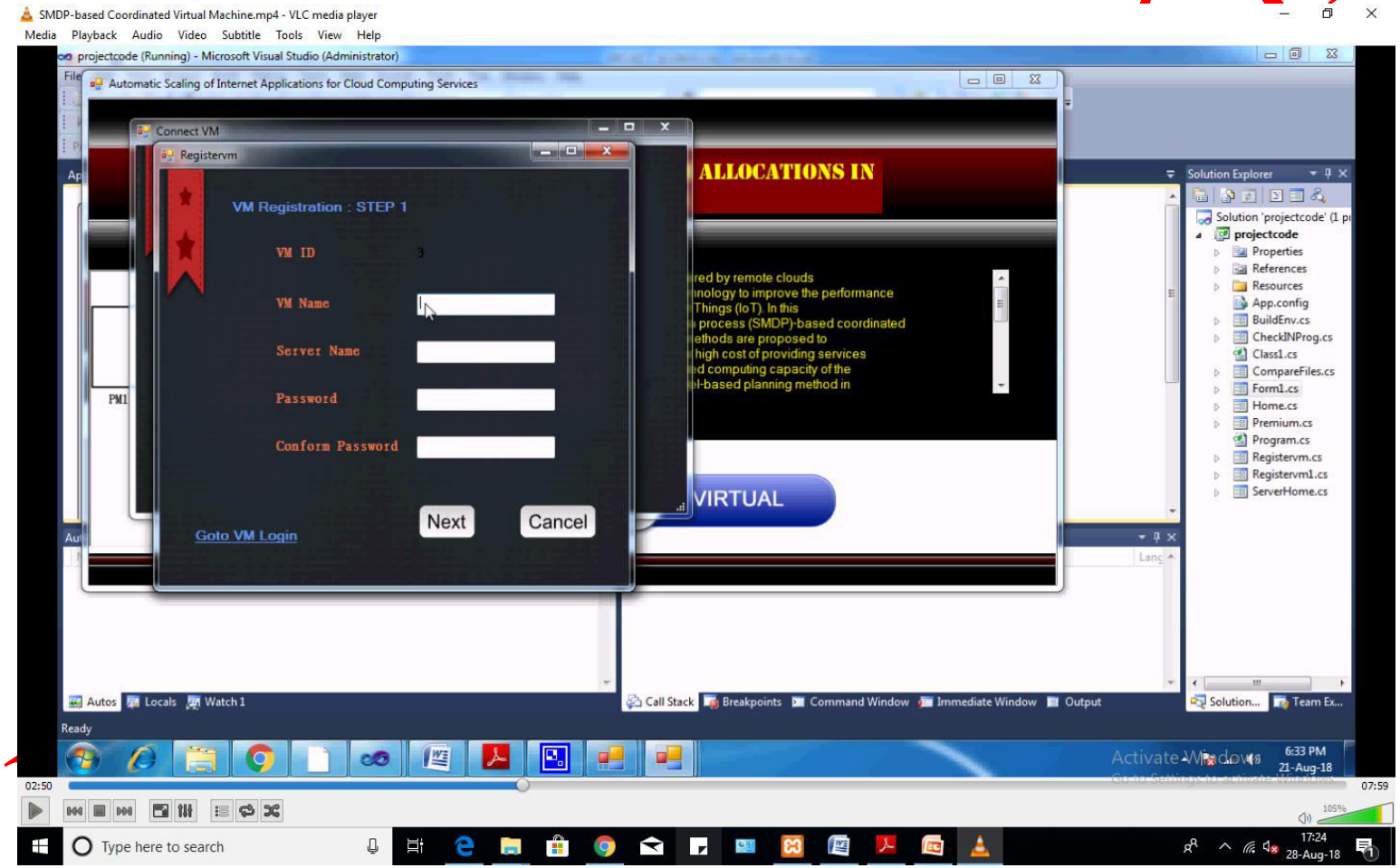
Type here to search
17:23
28-Aug-18

Register vm


SMDP-based Coordinated Virtual Machine.mp4 - VLC media player
Media Playback Audio Video Subtitle Tools View Help
projectcode (Running) - Microsoft Visual Studio (Administrator)
Automatic Scaling of Internet Applications for Cloud Computing Services
Connect VM
Registervm
VM Registration : STEP 1
VM ID
VM Name
Server Name
Password
Conform Password
Next
Cancel
Goto VM Login
ALLOCATIONS IN
VIRTUAL
Solution Explorer
projectcode
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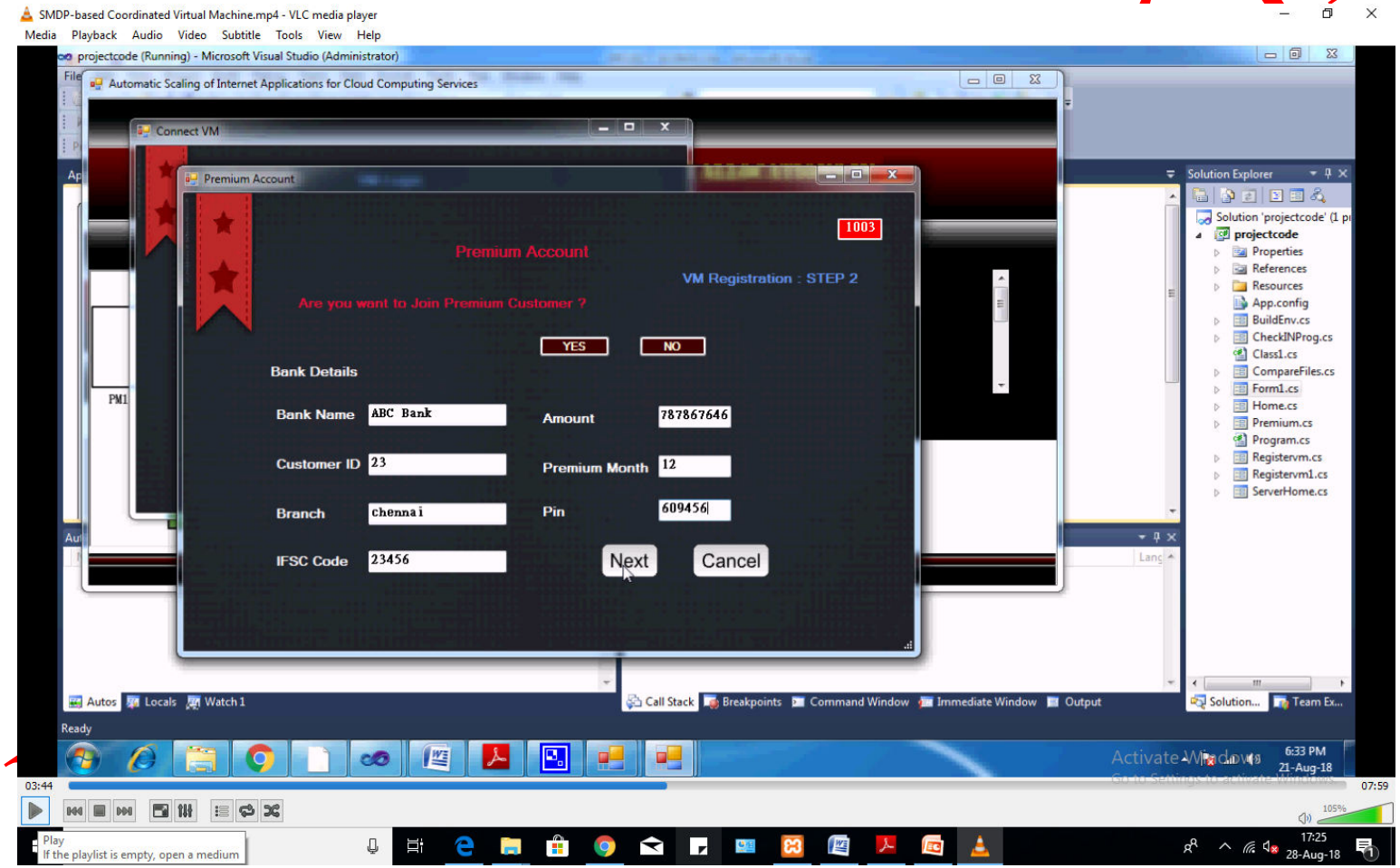
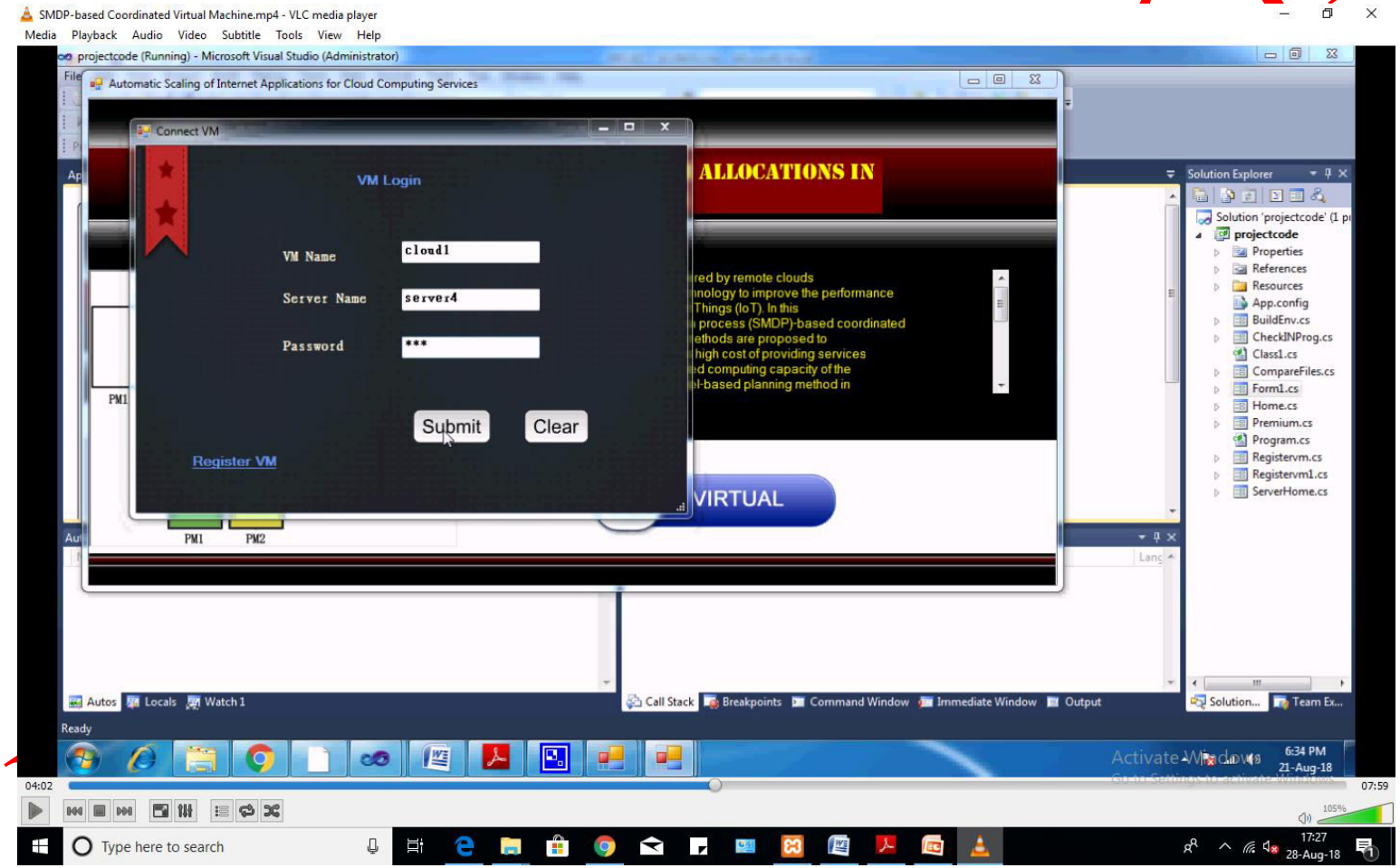
Registervm1.cs
ServerHome.cs
Autos Locals Watch 1
Call Stack Breakpoints Command Window Immediate Window Output
Ready
6:33 PM
21-Aug-18
02:50
07:59
Type here to search
17:24
28-Aug-18

Premium account



Vm login


SMDP-based Coordinated Virtual Machine.mp4 - VLC media player
Media Playback Audio Video Subtitle Tools View Help
projectcode (Running) - Microsoft Visual Studio (Administrator)
Automatic Scaling of Internet Applications for Cloud Computing Services
Connect VM
VM Login
VM Name
cloud1
Server Name
server4
Password
***
Submit
Clear
Register VM
ALLOCATIONS IN
VIRTUAL
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PM2
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Autos
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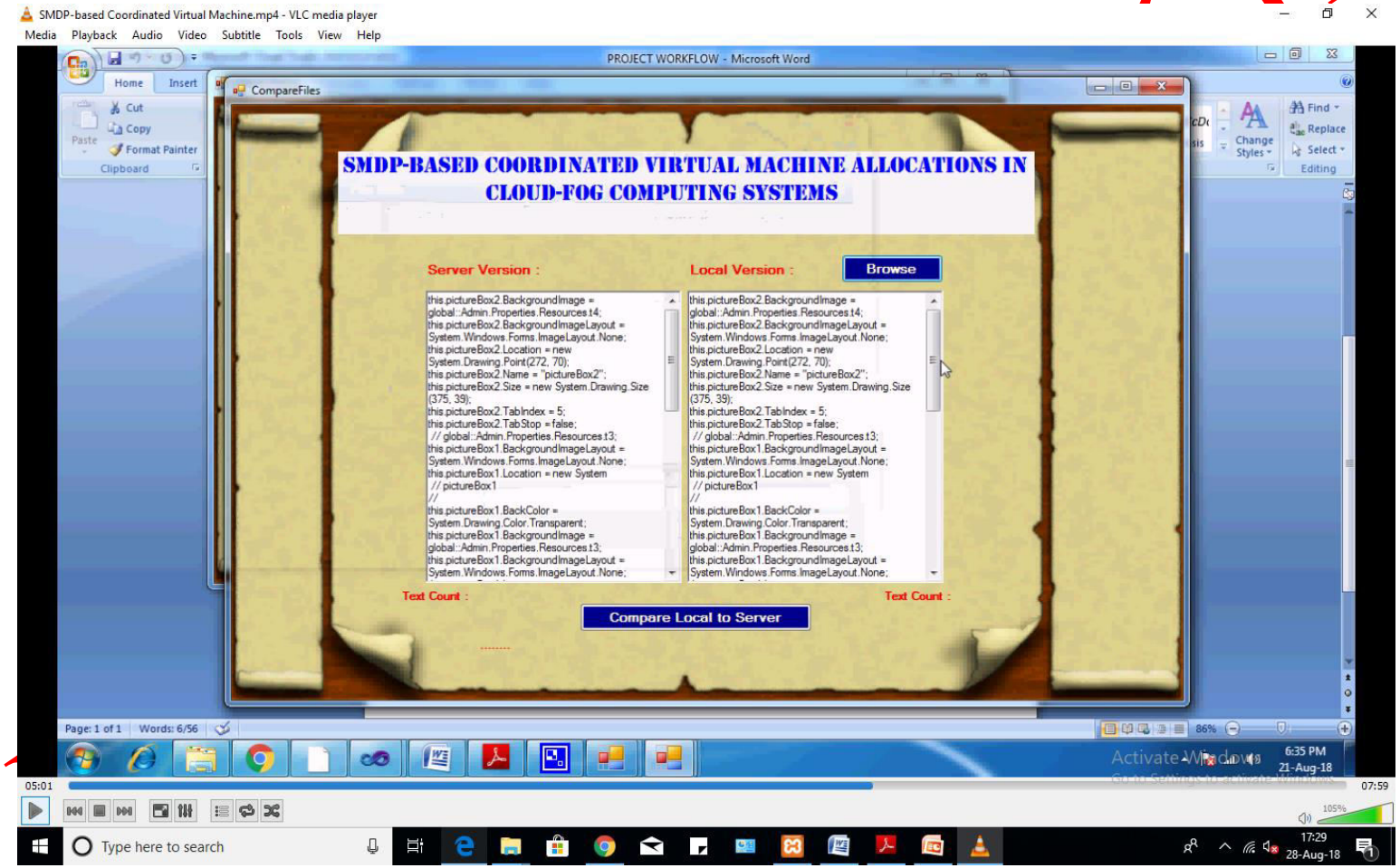
Call Stack
Breakpoints
Command Window
Immediate Window
Output
Ready
6:34 PM
21-Aug-18
04:02
07:59
Type here to search
17:27
28-Aug-18

Server file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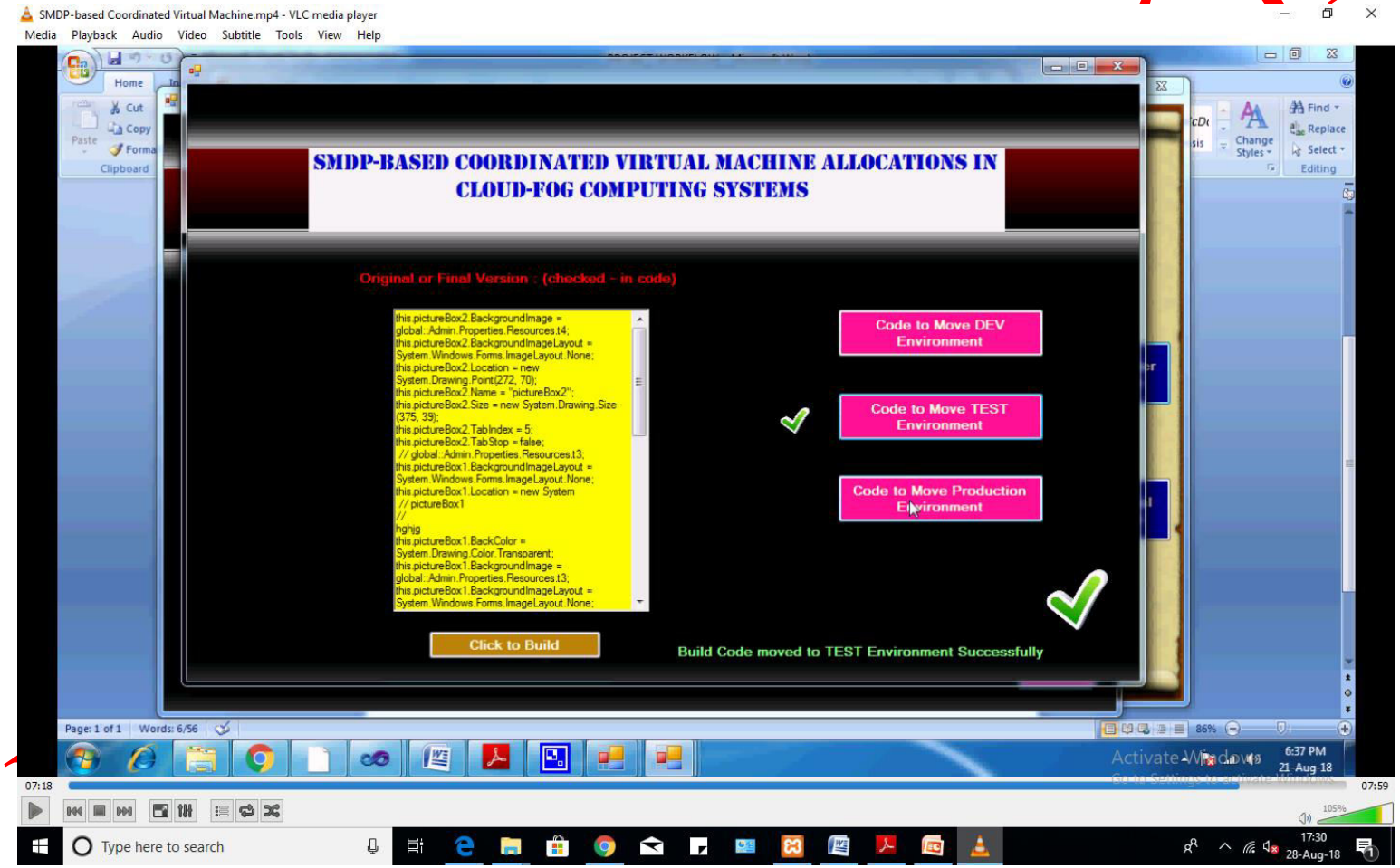
Media Playback Audio Video Subtitle Tools View Help
PROJECT WORKFLOW - Microsoft Word
CompareFiles
SMDP-BASED COORDINATED VIRTUAL MACHINE ALLOCATIONS IN CLOUD-FOG COMPUTING SYSTEMS
Server Version :
Local Version :
Browse
Text Count :
Text Count :
Compare Local to Server
Type here to search

Test environment



Conclusion

- In this paper, we presented two SMDP-based coordinated VM allocation methods for a cloud-fog computing system. We analyzed the difficulty of training the state transition probabilities and the expected time intervals between adjacent decision epochs for a generic SMDP, and used the CTMDP model to simplify the generic SMDP.
- The relative value iteration algorithm was used to find an asymptotically optimal VM allocation policy. To avoid the negative impact of the discrepancy between the assumption and the real model, the average reward reinforcement learning algorithm was leveraged to obtain an approximately optimal VM allocation policy.

Reference

- [1] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A vision, architectural elements, and future directions," *Future Gener. Comput. Syst., vol. 29, no 7, pp. 1645-1660, Sep. 2013.*
- [2] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, G. Lee, D. Patterson, A. Rabkin, I. Stoica and M. Zaharia, "A view of cloud computing," *Commun. ACM, vol. 53, no. 4, pp. 50–58, Apr. 2010.*
- [3] H. T. Dinh, C. Lee, D. Niyato and P. Wang, "A survey of mobile cloud computing: Architecture, applications, and approaches," *Wirel. Commun. Mob. Comput., vol. 13, no. 18, pp. 1587–1611, Dec. 2013.*