What is *Ad hoc* Cloud Computing?

- Harvest resources from *sporadically available, non-exclusive* and *unreliable* infrastructures.
What is *Ad hoc* Cloud Computing?

- Harvest resources from *sporadically available, non-exclusive* and *unreliable* infrastructures.
- Cannot migrate to cluster, Grid or cloud (public or private)
- Increase utilization and return on investment
- Combination of many computational models

<table>
<thead>
<tr>
<th></th>
<th>Cluster</th>
<th>Grid</th>
<th>Volunteer</th>
<th>Cloud</th>
<th>Ad hoc Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volunteer resources (non-dedicated)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assumes untrusted hosts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuity (proactive + distributed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Interference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverse Workloads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ad hoc Cloud Computing

Ad hoc Cloud Overview

Ad hoc Cloud hosts: employee workstations, your laptop, etc
Ad hoc Cloud Overview

Ad hoc Cloud Computing

Ad hoc Cloud

Host User

Cloud User

Organizational Infrastructure

Ad hoc Cloud

Ad-hoc guest (VM)

Cloudlet

Modified BOINC client; guest control, monitoring...
Ad hoc Cloud Overview

**ad hoc server**: host, guest, cloudlet and state management
Ad hoc Cloud Computing

Ad hoc Architecture Interactions

1. Cloud user job
2. Register
3. VM and script
4. Job X Details
5. Configure
6. Start VM
7. Get Job X
8. Monitor host/guest resources
9.1 Send host/guest status

Gary A. McGilvary, Adam Barker, Ashley Lloyd and Malcolm Atkinson. V-BOINC: The Virtualization of BOINC. CCGrid 2013
Ad hoc Cloud Computing

Ad hoc Architecture Interactions

9.1. Checkpoint VM
9.2. Distribute Checkpoint
9.3. Inform Server:
   VM ID
   Checkpoint ID
   Location
Ad hoc Architecture Interactions

9.2. Distribute Checkpoint

9.3. Inform Server: VM ID, Checkpoint ID, Location

10. Restore Checkpoint

11. Delete Restored Checkpoint
Ad hoc Cloud Computing

Peer-to-Peer (P2P) Checkpointing

\[
host\_reliability = \begin{cases} 
0 & \text{if } NF = CA \\
100 & \text{if } NF = 0 \\
(CC/CA) \times 100 & \text{otherwise}
\end{cases}
\]

NF = the total number of ad hoc host and guest failures,
CA = the total number of cloud jobs assigned to the ad hoc host,
CC = the total number of cloud jobs completed by the ad hoc host.

= 1.6%
Preliminary Evaluation

Key:
- **Job X Ad hoc host running job X becomes non-operational**
- **ERROR Restoration error caused by VirtualBox**
- **Complete Job completes before virtual machine restoration**

<table>
<thead>
<tr>
<th>VM ID</th>
<th>EDIM1 ID</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>174</td>
<td>143</td>
<td>99.99664</td>
</tr>
<tr>
<td>175</td>
<td>165</td>
<td>99.970535</td>
</tr>
<tr>
<td>172</td>
<td>155</td>
<td>99.99762</td>
</tr>
<tr>
<td>171</td>
<td>140</td>
<td>99.9804</td>
</tr>
<tr>
<td>184</td>
<td>159</td>
<td>99.97182</td>
</tr>
<tr>
<td>199</td>
<td>147</td>
<td>99.98353</td>
</tr>
<tr>
<td>187</td>
<td>150</td>
<td>99.79867</td>
</tr>
<tr>
<td>179</td>
<td>168</td>
<td>99.98573</td>
</tr>
<tr>
<td>185</td>
<td>141</td>
<td>92.57216</td>
</tr>
<tr>
<td>193</td>
<td>142</td>
<td>99.988556</td>
</tr>
<tr>
<td>178</td>
<td>169</td>
<td>99.98711</td>
</tr>
<tr>
<td>192</td>
<td>156</td>
<td>99.939476</td>
</tr>
<tr>
<td>189</td>
<td>167</td>
<td>99.77488</td>
</tr>
<tr>
<td>188</td>
<td>152</td>
<td>99.061005</td>
</tr>
<tr>
<td>195</td>
<td>148</td>
<td>99.41439</td>
</tr>
<tr>
<td>173</td>
<td>144</td>
<td>99.981492</td>
</tr>
</tbody>
</table>

Job Diagram:
- **Job 1**
- **Job 2**
- **Job 3**
- **Job 4**
- **Job 5**
- **Job 6**
- **Job 7**
- **Job 8**
- **Job 9**
- **Job 10**
- **Job 11**
- **Job 12**
- **Job 13**
- **Job 14**
- **Job 15**

**Ad hoc Cloud Computing**
Preliminary Evaluation

Ad hoc Cloud Computing

Up to 93.3% reliability
Preliminary Evaluation

Ad hoc Cloud vs Amazon EC2

inc. 1 VM migration @ 24s
Conclusions

• A new computation model useful in a number of scenarios
• Built on BOINC and V-BOINC. Concepts from Grid, Cloud, etc
• Reliability introduced by P2P checkpointing and distribution
• Suitable for CPU, memory and I/O intensive tasks
• Initial experimentation is promising
• Feasible, reliable and offers reasonable performance!

www.garymcgilvary.co.uk  www.era.lib.ed.ac.uk/handle/1842/9652
Thank You.

Questions?