

**Getting started** 



# 分布式并行计算

# UM 软件入门系列教程 (10)

四川同算科技有限公司 译

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联系方式

最新版的UM软件和相应的用户手册下载地址:

<u>http://www.universalmechanism.com/en/pages/index.php?id=3</u>. 若无法访问,请点击: <u>http://www.umlab.ru/en/pages/index.php?id=3</u>. 在使用过程中,读者如有任何报错、疑问和建议,请发送邮件至:

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# 1. 简介

UM Cluster 是 Universal Mechanism 软件的分布式并行计算模块,可在局域网内组建计算机集群,进行大规模的分布式并行计算,提高硬件资源利用率,缩短计算周期。

UM Cluster 模块由两部分组成:服务器和客户端。本文中提到的 UM Cluster 或 Cluster 指的是整个分布式并行计算系统。其中管理并行计算任务的服务器称 之为 UM Cluster Server,执行计算任务的客户端称之为 UM Cluster Client。

UM Cluster 的服务器和客户端都属于 UM 软件。其中,在客户端计算机上并不需要安装完整的 UM 软件,只需安装必要的组件。

UM 软件的许可政策并未限制客户端计算机的数量,只需要服务器计算机具 有该模块的授权即可。

UM 提供独立的客户端程序 UM Cluster Client,可在官方网站下载: <u>http://www.umlab.ru/en/pages/index.php?id=3</u>

客户端缺省安装位置为 C:\Program Files\UM Software Lab\UM Cluster Client。

服务器是随 UM 主程序安装的,无需单独安装,缺省位于 C:\Program Files\UM Software Lab\Universal Mechanism\9\bin

兼容性

经测试, UM 软件可以安装在 64 位的 Windows 7/8.1/10, Windows Server 2008/ 2012R2/2016/2019。其他版本的操作系统未测试。

课程内容

- 1. 如何在客户端计算机上安装独立的 UM Cluster Client 分布式并行计算 程序。
- 2. 了解 UM Cluster 并行计算对操作系统的一些基本设置要求。
- 3. 使用 UM Cluster Server 创建用于并行计算的客户端计算机列表。
- 4. 使用 UM Cluster Server 检测客户端计算机的状态。
- 5. 使用 UM Cluster Server 进行客户端程序远程安装。
- 6. 运行分布式并行计算。





# 2. 分布式并行计算

## 2.1 运行方式

当我们使用 UM 软件建立一个 Scanning 批处理项目时,在 Run 页面,有个 Distributed Calculation 选项。若将它选上,就表示调用分布式并行计算模块。 不过前提是要先设置好用于并行计算的客户端计算机列表,并保证这些计算机可 正常调用。

O UM - Simulation - c:\users\public\documents\um software lab\universal mechani	ism\9\my projects\scan2\oscillator — 🗆 🗙
File Analysis Scanning Tools Windows Help	
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scan2 - scanning	
General Alternatives Run Results	
i	Running processes Count of processes 4
Eventing	
Run Stop Turn off computer when project do	ne la
Done 0% (0/27)	

#### 图 2.1 UM 批处理仿真界面

为了使得分布式并行计算能正常进行,我们必须先完成以下操作:

- 1. 在客户端计算机上安装独立的 UM Cluster Client 客户端程序;
- 2. 在服务器计算机上使用 UM Cluster Sever 程序配置好客户端计算机列表;
- 3. 检查服务器和客户端计算机之间的通信和交互。

接下来,我们将介绍如何进行这些操作。





### 2.2 配置客户端

#### 2.2.1 关于操作系统

UM Cluster Server 基于 Windows 操作系统内置的网络机制(如:服务、子系统)实现服务器与客户端计算机的远程交互,这些交互包含以下内容:

- 服务器与客户端计算机之间的文件交换;
- 从客户端计算机运行 UM 软件的求解器 UM Solver;
- 从服务器远程控制客户端计算机执行计算。

以上这些操作需要相应的系统权限,在 Windows Server

2008/2012/2016/2019 等服务器操作系统中是缺省打开的,而对于用户常用的 Windows Vista, Windows7/8/10 这类系统则缺省是关闭的。

具体来说,以下四个选项是决定远程交互是否成功的关键,缺一不可:

- 1. UAC (用户帐户控制)
- 2. Server (服务器服务)
- 3. Remote registry (远程注册表)
- 4. Firewall (防火墙)

以上任何设置不当,都会导致服务器与客户端不能正常交互。为简便起见, UM 软件将这四个选项简称为 USRF,分别是四个选项的首字母。

用户在安装独立的 UM Cluster Client 程序时,程序已经将系统调整为最佳的设置,一般不需要手动修改。



#### 2.2.2 安装客户端程序

客户端程序安装过程如下:

- 从官方网站 <u>http://www.umlab.ru/en/pages/index.php?id=3</u> 获取最新的分 布式并行计算客户端安装程序;
- 2. 在要作为客户端的计算机上安装客户端程序 UM Cluster Client.exe;
- 3. 完成安装,并按提示重启计算机;
- 重启后,客户端监视器 UM Monitor 会自动运行,并最小化到任务栏(隐藏图标组),该程序用于在客户端检测和监视。

从任务栏点开 UM Monitor,在 Network availability 页面的 USRF 四个标签 项都是绿色,如图 2.2 所示。

Condition	Performance Sch	hedule Se	rvice	Log	Networ	rk availabil	ity					
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	Configure Fire	wall	Adv	rirewall	í.						~	
		3	Allow	use of	this com	puter in d	istributed	computing				
	Permission app	blied	2	5.09.202	20 18:03:39							
Comput	ter is a member of v	workgroup C	LUSTE	ER	UAC	Server	Registry	Firewall				
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#### 图 2.2 UM Monitor 界面

正常情况,UAC、Server、Registry 和 Firewall 四个标签都显示为绿色,表明相应的系统权限已经开启,可以用于分布式并行计算。





然而,有时候由于各种原因,未能全部修改,如图 2.3 所示。

此时,可点击 Allow use of this computer in distributed computing,然后会

提示重启计算机,重启后一般就全部变绿了。

Condition	Performance	Schedule	Service	Log	Network availability	
Permiss	ion to remote	elv use this	s comput	er		
Se co	etting this permiss omputer is open fo	sion allows the or free access	e cluster se s from the r	rver to p network.	perform remote calculations on this computer. However, the credentials for the connection must be registered on	his does not mean that t the cluster server.
	Configure	Firewall	Ad	vrirewal	t.	~
			Allow	use of	this computer in distributed computing	
	Permission	applied	2	25.09.20	20 18:03:39	
Comput	er is a member	of workgro	up CLUST	ER	UAC Server Registry Firewall	
				• • • • • • •	P	
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#### 图 2.3 服务器和远程注册表未开启

如果要恢复之前的设置,可点击 Restore this computer initial network protection settings。





### 2.3 配置服务器

在分布式并行计算的服务器端,我们需要创建客户端计算机列表,并检查连接和交互状态。使用 UM Cluster Server 服务器管理程序可以添加客户端、安装客户端程序和检查状态。作为示例,下面我们将添加三个客户端计算机,组建一个微型集群。

2.3.1 首次启动服务器控制程序

从开始菜单 Universal Mechanism 9 x64 | Tools | UM Cluster Server 运行服 务器管理程序。

第一次运行时,如图 2.4 所示,计算机列表显示为空,程序自动探测出服务 器本机所在的网段。

UM Cluster server	
File List of computers Service Help	
2 🤫 🖬 😔	
List of computers	🕘 Scanning 🛛 Tomputer ist wizard 🖏 Clent event logs 📃 Remote desktop
	Welcome to UM Cluster Server!
	With this program, the simulation process, divided into many experiments, will be executed in parallel on other computers available on your local network. This will significantly reduce the total task of execution time. Instability of the providence processor to network memory hand a computers available on your local network. This will significantly reduce the total task of execution time. Instability of the providence processor to network memory hand a computers available on your local network. This will significantly reduce the total task of execution time. Instability of the providence processor to network memory hand a computer without used to the processor to the processor to take the processor tother to take the processor to take the processor tother
EØ	Is to diser accounts that have administrative rights on remote computers, and a list of computers on which experiments will be performed. If you have questions about creating these lists, control your accounts that have administrative rights about creating these lists, control you are accounts that have administrative rights about creating these lists.
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	Process to autor round computers to the computation
	≥lob net add computers with unsuccessful connect.
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Instal date	Scan settings
Model	Count of computers explored simultaneously 60 🖨
BIOS Baseboard	☑ Install client programs
Scaning	Permissions for project execution are defined by remote users
Scaning	
Performance	Add computers to lat
Performance	Warning! Creation of the list of computers can take some time
Processor	
Frequency	
Name	
<ul><li></li></ul>	
Processor utilization (%)	30.09.2020 0:54:55 No computers with installed client are found. Implementation of projects is possible only on the local computer.
	30.09.2020 0:54:55 Program started
. Landerson Astrony	
Network traffic (In-Out, kb/s)	
10.1	
5	
0 I	Number of computers 0     Off 0     Off 0     Alowed to use 0     Busy in calculations 0
C:\Users\Public\Documents\UM Software Lab\I	Jniversal Mechanism\UM Cluster Client\Config\Config5.dls Idle Experiments 120/0 [CLUSTER-SRV-01[192.168.1.44]]

图 2.4 首次运行的界面





#### 2.3.2 将服务器本机添加到客户端计算机列表

在 UM Cluster Server 界面左侧有一列图标,用于管理客户端计算机列表, 其中只有第一个(Add computer)为激活状态。

点击这个 Add computer 图标,弹出计算机参数设置窗口。现在我们把本机 添加到列表,最下一栏显示了 IP 地址和计算机名。在 IP-address 处输入 IP (本 文为 192.168.1.44),会自动显示计算机名。对于本机,无需设置用户名和密码。







#### 2.3.3 添加一个局域网内的计算机到客户端列表

现在,我们添加一个已经安装了 UM Cluster Client 独立程序的计算机作为 客户端,安装方法已经在章节 2.2.2 介绍。

我们需要知道这台计算机的 IP 地址、具有管理员权限的用户帐户及密码。 本文以 IP 192.168.54 为例,请读者自行找到自己局域网内计算机的 IP 地址。

需要注意以下几点:

- 当在 IP-address 一栏输入局域网中某台计算机的 IP 地址时,在 Name 一栏会自动识别出计算机名;反之,如果先在 Name 一栏输入正确的计 算机名,程序也会自动搜索获得对应的 IP 地址;
- 程序不支持添加重复的 **IP** 和计算机名;
- 计算机的用户帐户格式如图 2.5 所示,"计算机名\用户名";
- 列表中的计算机及用户帐户信息以加密形式保存在UM Cluster 程序中, 足够安全。

这里,我们在第一次输入密码时,请先故意输入一个错误的密码。

这样,我们的列表就有了两个计算机。

UM Cluster server					– 🗆 🗙
File List of computers Service Help					
2 🥦 🖬 🎯					
List of computers	Granning     Granning     Granning     Welcome to UH Clust     "     "     With this program     trme. Instalation of     accounts that have     administrator."	New	logs  Remote desktop many experiments, wil be executiv experiments or remote computers, and a list of computers on	d in parallel on other computers available on yours is automated and occurs without user intervents which experiments will be performed. If you have	I local network. The well agenticatly reduce the total task execution on, eleftre you begin, you need to create two lates a lat of user questions about creating these lists, contact your system
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1	Na User Windows acco	IP-address	192.168.1.54		
SK.	Computer list	Computer name	CLUST-CLIENT-01	?	
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Name Physical memory C				Save Cancel	
Processor utilization (%)	30.09.2020 15:29:52 No cc 30.09.2020 15:29:52 Progr 30.09.2020 15:29:52 Progr 30.09.2020 15:29:56 Progr 30.09.2020 15:26:26 No cc 30.09.2020 15:26:26 Progr	orrouters with installed client are fou am started am finished orrouters with installed client are fou am started	and. Implementation of projects is p	ossible only on the local computer.	
30	Number of computers 1	Cients installed 0	Off 0	On 1 Allowed to use 1	Busy in calculations 0
C:\Users\Public\Documents\UM Software Lab	Universal Mechanism\UN	A Cluster Client\Config\Config	5.dls Idle	Experiments 120/0	CLUSTER-SRV-01[192.168.1.44]

图 2.5 添加新的计算机到集群列表





#### 2.3.4 选择要用来进行并行计算的计算机

在并行计算开始之前,我们必须先在 UM Cluster Server 界面的列表中勾选 若干台客户端计算机。

当我们选择上一步新添加的那台计算机时,程序会提示错误,如图 2.6 所示。 这个错误提示是说服务器并不知道这台客户端计算机是否已安装了 UM Cluster Client 客户端程序,因为在添加计算机时并未作此检测。

服务器可以通过两个操作来检测客户端计算机的状态:一是获取计算机参数, 二是强制远程安装客户端程序。

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9	Windows account	.its					
	User Window	is accounts are not de	med				
2		Mana	ige accounts				
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0	Scan filte	rs					
为	Do n	ot replace client progr	ams on computers with o	luster			
2	Skip	computers with install	ed client				
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30					_		

图 2.6 提示该计算机无法用于并行计算

现在我们可以尝试,选中这台客户端计算机,点右键,选择菜单 Explore computer hardware,如图 2.7 所示。

请注意,先前我们故意输错了用户密码,故此时程序会返回错误信息:Invalid username or password。服务器操作日志位于底部窗口。

所有集群相关的组件都与 Windows 操作系统的服务有关,如果没有足够的 权限访问这些系统服务,就会收到错误提示,无法完成所需操作。





Current Union     Compare Intervent     Compare Intervent	rs 7	🙆 Scanning 🛛 📅 Computer list	wizard 🗔 Client event logs	Remote desktop			
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图 2.7 获取计算机参数时的反馈

现在我们从列表中双击这台客户端计算机,在参数页面设置正确的密码。 然后再次尝试获取计算机参数(点**右键**,选择菜单 Explore computer hardware)。如图 2.8 所示,没有提示任何错误,这样我们就可以选择这台计算 机参与分布式并行计算。





DIM Cluster ser	ver						
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List of computers		& Scanning	Computer list wizard 0. Client eve	ent logs 🔜 Remote desktop			
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#### 2.3.5 添加第三个计算机到客户端计算机列表

下面我们再添加一台客户端计算机到集群。本例的 IP 是 192.168.1.38。请读 者输入自己局域网的一台可用计算机的 IP 地址。

请按上一节的步骤执行:

- 添加计算机
- 输入 IP 地址
- 输入用户名和密码
- 获取计算机参数
- 至此,我们的列表中就有了三台计算机。





#### 2.3.6 远程强制安装客户端程序

前面我们已经按照规定步骤添加了三台客户端计算机,一般情况是可以直接 用于并行计算。然而有时候会出现问题,特别是经过一段时间,我们不清楚那些 计算机的客户端程序或相关设置有没有被更改。因此为保险起见,最好从服务器 统一执行一次远程强制安装客户端程序的操作。

1. 在 UM Cluster Server 界面,全选列表中的计算机 (Ctrl+A);

2. 点右键,选择菜单 Install client programs to computer。

这样集群服务器就会在所有客户端计算机(本机除外)上重新安装客户端程序,以覆盖以前的版本。



图 2.9 远程安装客户端程序

安装过程很快就能完成,如果有报错,会在日志窗口显示。





### 2.4 准备运行并行计算模型

经过前面的一系列操作,我们就建立了一个包含三个客户端计算机的集群列 表,可以用于分布式并行计算。

有关 UM Cluster 模块更详细的介绍,请参阅用户手册第 23 章。这里,我们 着重强调以下几点:

- 在服务器和客户端可配置硬件资源,缺省的设置是针对小型项目的,服务器本身也参与计算。然而,随着集群中客户端计算机数量的增加,服务器需要更多的资源去管理计算过程,用于计算的能力就会减弱。因此,如果客户端超过10个,我们就建议取消选择 Allow this computer to be used as a cluster client (菜单 Service| Settings),如图 2.10。
- 无论是独立安装,还是远程安装客户端程序,缺省设置都是所有的CPU都用于分布式并行计算。如果计算机还要进行其他程序的工作,那最好手动分配硬件资源。
- 当客户端程序安装后,集群的所有组件(包括服务器、监视器和代理)等的 操作日志都自动创建,既可以通过 Windows 系统查看,也可以在服务器程序 查看。
- 集群服务器可以在开始执行并行计算时远程唤醒客户端计算机,并在计算完成后关闭它。一般来说,在用户的操作系统,远程开关计算机是禁用状态。
   若要在客户端计算机使用该功能,必须提前设置好。





Level for logging operations   Event log size for every computer   Image:	ieneral	Scan	Address Exc	lusions			
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Event log size for every computer 100 •   Number of packets for determining computer availability 1   Allow this computer to be used as a cluster client   Hide passwords   Hide to tray   Sound notifications   Prompt for software installation   Warn about the absence of selected clients   Use bug report   The position of the main window when receiving a task   Without change	Level	for logg	ing operation	5	Debug		-
Number of packets for determining computer availability       1         Image: Allow this computer to be used as a cluster client         Image: Hide passwords         Image: Hide to tray         Sound notifications         Image: Prompt for software installation         Image: Warn about the absence of selected clients         Image: Use bug report         Image: The position of the main window when receiving a task         Image: Without change	Event	log size	e for every co	mputer		100 🚖	
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图 2.10 设置集群服务器也参与计算

现在,我们来设置客户端的计算机使用一半的硬件资源参与计算。

- 从客户端计算机打开 UM Monitor (开机时一般最小化在右侧隐藏的图标)
- 转到 Schedule 页面
- 从 Templates 下拉菜单,选择 Allow half number of processors,如图 2.11 所示。





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图 2.11 配置客户端硬件资源





# 2.5 运行并行计算

运行 UM Simulation 仿真程序,从 Scanning 加载一个批处理项目,勾选 Distributed Calculation,点击 Run,这时 UM Cluster 开始执行并行计算。 其中一台关机状态的计算机也会自动开即运行,因为我们提前设置了远程权 限和相关选项 Wake up computer to perform calculations。

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图 2.13 计算完成后的统计信息

Universal Mechanism 9