From XtreemOS Grids to Contrail Clouds

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Context

• Distributed operating system for Grids and Cloud federations
  • XtreemOS Grid operating system (2006-...)
  • Contrail system for cloud federations (2010-...)

• Large scale distributed systems
  – Wide area computing infrastructure spanning multiple administrative domains
  – Dynamic nature & uncertainty
  – Huge amount of resources & users
Outline

• XtreemOS Grid operating system
• XtreemOS: from Grid to Cloud computing
• Overview of Contrail European project
XtreemOS in a Nutshell

• Distributed operating system for large scale dynamic Grids
  – “Operating system” approach
    • Comprehensive set of cooperating system services
  – Ease of use
    • “Bring the Grid to standard users”
      – Unix system interface
      – SAGA programming interface
  – Scalability
    • Dependable system
XtreemOS Software Architecture

Grid Applications

XOSAGA

XtreemOS-G

Job & resource management
XtreemGCP

Security services
VO management

Data Management
XtreemFS
OSS

Infrastructure for Highly Available & Scalable Services

RSS
SRDS
ADS
DIXI
Virtual nodes
Distributed Servers
Scalaris

Extensions to Linux OS for VO support & checkpointing

process group checkpointers

XtreemOS-F

Linux
PC

Linux SSI
Cluster

Embedded Linux
Mobile Device
XtreemOS Software Architecture

Grid Applications

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Job & resource management
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Linux
PC

Embedded Linux
Mobile Device
Applications

- Electromagnetics
- CAE
- Mobile applications
- Virtual Reality
- Fluid Dynamics
- Tomography
- Particle Physics
- Cloud Computing
- Enterprise solutions
- Optimization
- Biology
XtreemOS Software

• XtreemOS 2.1.2 open source Grid operating system
  – PC, clusters, netbooks, PDA, smart phones
• Packaged for Linux distributions
  – Mandriva, Debian, Asianux
• Ready to use VM for KVM & Virtual Box
• Tool for automatic deployment of XtreemOS on Grid’5000
• XtreemOS open permanent testbed
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XtreemOS and Cloud Computing

• XtreemOS: a distributed operating system designed for Grids
  – Project started in June 2006

• Cloud computing new era started in late 2007
  – Lots of media attention, new products announced every day, etc.

• Question
  – How relevant is XtreemOS in this new context?
XtreemOS & Cloud Computing

XOS over Clouds

**XtreemOS**

Virtualization

Bare HW, Bare HW, Bare HW, Bare HW

Extending an XtreemOS Grid with dynamically provisioned resources

Cooperation over federated clouds using XtreemOS Grid system

XOS over Clouds

**XtreemOS**

Virtualization

Bare HW, Bare HW, Bare HW, Bare HW

XOS for IaaS

**XtreemOS**

Virtualization

Bare HW, Bare HW, Bare HW, Bare HW

XtreemOS as an OS for IaaS clouds over hardware resources in different sites or provisioned by different suppliers
Provisioning Resources from Clouds

XOS over Clouds

1. Request VM creation
2. Resource applies for a certificate
3. Confirm resource
4. Send signed certificate

Cloud client

Service Node
- Nimbus
- Storage

VMM Node
- control
- libvirt
- Xen / KVM
- VM
- VM

DHCP Server

XOS Resource

XtreemOS grid

Extension on the cloud

Virtualization

Cloud

Bare HW

Bare HW

Bare HW

Bare HW

XOS Core

XOS Resource

XOS Core

XOS Resource

XOS Core

XOS Resource

XOS Core

XOS Resource

XOS Core

XOS Resource
XtreemOS Appliances for Clouds

Automatic deployment of an XtreemOS Grid on bare hardware
XtreemOS Appliances for Clouds

- Nimbus/Cumulus
- OpenNebula
- Eucalyptus
- EC2/S3
XtreemOS Appliances for Clouds

Cooperation over federated virtualized infrastructures
XtreemOS as an IaaS Cloud OS
XtreemOS as an IaaS Cloud Operating System

• Virtualization used in XtreemOS for isolation
  – Linux cgroups, containers, VM used to execute jobs
• XtreemOS could manage VM instead of jobs
  – EC2 interface
• XtreemFS could be used as a cloud storage system
  – VM images storage
  – S3 interface
• XtreemOS as a system to provide an IaaS cloud service on top of hardware resources supplied by different providers
  – Management of resources in different sites and administrative domains
  – VO infrastructure to manage resource usage policies
    • Customer classes
    • Bare hardware suppliers
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Contrail Objectives

- Design, implement, validate and promote an open source software stack for cloud computing

- Outcome
  - A tightly integrated open source software stack including a comprehensive set of system, runtime and high level services providing standardized interfaces for cooperation and resource sharing in Cloud federations
Contrail Vision

- *Federation of resources provided by public and private clouds*
  - Resources offered by different operators will be integrated into a *single homogeneous Federated Cloud* that users can access seamlessly
  - *Any organization* should be able to be *both a Cloud provider* when its IT infrastructure is not used at its maximal capacity, *and a Cloud customer* in periods of peak activity
Contrail Challenges

- Vertical integration of IaaS and PaaS in an comprehensive open source cloud computing software
- SLA enforcement through QoS & QoP management in all layers
- Sub-rent resources and federate clouds
- Avoidance of cloud user lock-in providing a live migration service for cloud federations
Contrail Approach

• Leverage and extend the results from the XtreemOS FP6 IP project
• Cooperate with other open source cloud computing projects
  – Standardize cloud API
  – Re-use existing software relevant for Contrail
  – Make sky computing real
  – Build a strong European community promoting open source cloud computing software
Contrail in a Nutshell

High-throughput electronic drug discovery

Use cases and Exploitation
SP5

Distributed Provision of Georeferentiated Data

Multimedia Processing Service Marketplace

Platform-as-a-Service
SP3

Key-value store

SQL

Map/Reduce

Bag-of-Tasks

Web-servers

Core Virtual Infrastructure Layer
SP2

well known abstractions
(POSIX API, x86 ISA, IP Network)

Network

Compute

Storage

Security

Cloud User Interface + API

Resource Selection

Monitoring

Accounting

SLAs

Providers

Integration, Validation and Testing
SP4

IaaS Federation
(distr. registry, VO management, identity mgmt)

Cloud Federation Management
SP1
Contrail Consortium

- Starting date: October 2010
- Duration: 3 years
- Budget: 11.4 M€
- EC funding: 8.3 M€
Concluding Remarks

• XtreemOS: a sustainable technology
  – Free software in open source development
  – XtreemOS open testbed available for the community
    • Support provided

• Contrail project just starting
  – Leveraging XtreemOS results
  – Open source software for cloud federations

• External contributions welcome
More information

http://www.xtreemos.eu
IST-FP6-033576

http://www.contrail-project.eu
ICT-FP7-257438