

Resource Disaggregation for Virtual Data Center Provisioning in Optical Data Centers

Tanjila Ahmed

Outline

- Big Data Challenges for Datacenter Network
- Evolution of Datacenter Architecture
- Server Centric Datacenter Architecture Problems
- Resource Disaggregation
- Infrastructure as a Service
- Related Previous Works
- HTC-DC Architecture(Huawei)
- Conclusion

References

1. Albert Pagès , Rubén Serrano, Jordi Perelló, and Salvatore Spadaro, “**On the benefits of resource disaggregation for virtual data centre provisioning in optical data centres**”, Computer Communications, vol. 107, pp. 60–74, April 2017.
2. Huawei technical white paper, **High Throughput Computing Data Center Architecture** (2014) [Available Online] http://www.huawei.com/ilink/en/download/HW_349607&usg=AFQjCNE0m-KD71dxJeRf1cJSkNaJbpNgnw&cad=rja.
3. C. Reiss, J. Wilkes, J.L. Hellerstein, **Google Cluster-Usage Traces: Format + Schema**,(2012) Google Technical Report[Available Online] <http://code.google.com/p/googleclusterdata/wiki/TraceVersion2>, Accessed May 2016.

Evolution of Human Society

4000 BC~1763



Agricultural Society:

Avg. consumption of Protein per Capita

Protein consumption as a identity for the development of civilization

1764~1970



Industrial Society:

Avg. consumption of Electricity per Capita

1970 (kWh)

US: 723

EU: 2888

CN: 151(1971)*

1971~2011



Information Society:

Avg. Internet access/per Capita

2011 (Every 100 Person) *

US: 78

EU: 72

CN: 38

2012~present



Post-Info Society:

Avg. consumption of Info-Data per Capita

2012 (Person Per Year) **

US: 1960GB

EU: 1930GB

CN: 186GB

Technological innovation promotes the development of civilization

* Source: <http://data.worldbank.org>

** Source: IDC, 2012

Courtesy [2]

HUAWEI TECHNOLOGIES CO., LTD.



Big Data Challenges to Data Centers

Limitations of Current DC

- | | | | | |
|---|--|---|---|--|
| <ul style="list-style-type: none">• Data processing capability• I/O bottleneck | <ul style="list-style-type: none">• Typically Utilization<30%• Virtualization with high overhead | <ul style="list-style-type: none">• Limited flexibility for deployment and configuration• Complex operations | <ul style="list-style-type: none">• High speed copper interconnect• DC-level large-scaled interconnect | <ul style="list-style-type: none">• Lower power efficiency |
|---|--|---|---|--|

Throughput

- New medium
- New architecture
- New access Mechanism

Resource Utilization

- Resource disaggregation
- On-demand and flexible resource allocation

Management

- Intelligent Management
- Self-healing
- Self-configuration
- Software-defined

Scalability

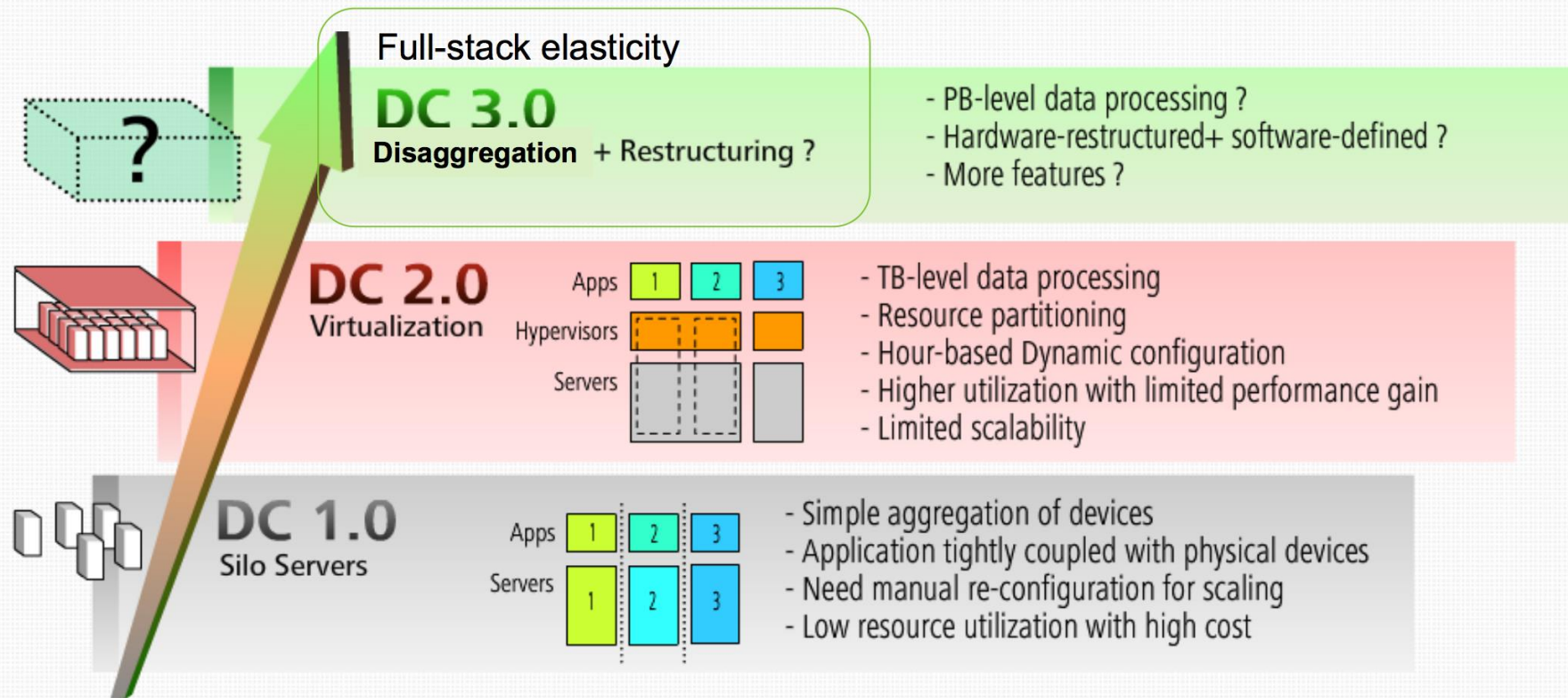
- Optics based interconnect

Energy Efficiency

- New architecture for energy efficient computing

Strategies

Evolution of Data Center Architecture



HUAWEI TECHNOLOGIES CO., LTD.



Courtesy [2]

UC DAVIS

Server Centric Datacenter Problems [1]

1. Services/tasks in DCs are executed on top of Virtual Machines. (VMs)
2. Heterogeneous VM computing resource demands can lead to server underutilization
3. Google published data regarding high disparity of storage/memory to CPU usage for their tasks [3].
4. Tight integration of components (CPU, memory modules, disk, network interface card, etc...) into a single motherboard limits upgrade

Resource Disaggregation [1]

- Disaggregate components by physically decoupling & mounting in separated blades
- Resource blades grouped in racks or mono-hardware racks
- Blades are interconnected through intra-DCN fabric
- Allocate exact amount of resources needed to provision a VDC instance

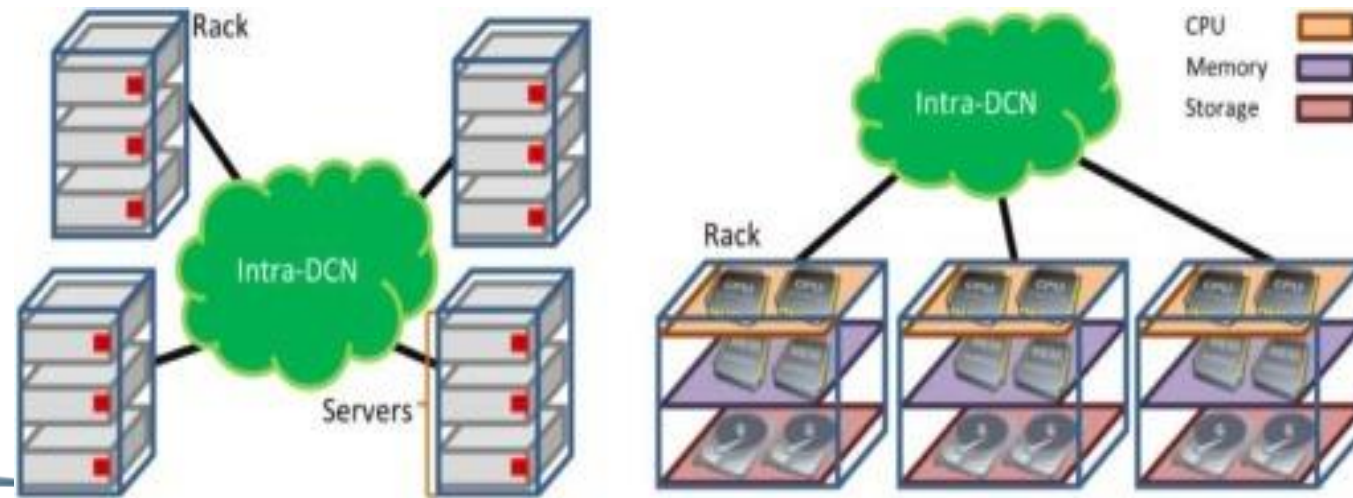


Fig. 1 Server-centric (left) vs. disaggregated (right) DC architecture.

Resource Disaggregation [1]

1. Easier Hardware upgrade.
2. Reducing associated CAPEX.
3. Brings modularity to systems, enabling easier hardware upgrades.

Infrastructure as a Service(IaaS) [1]

- IaaS allows offering a portion of the physical infrastructure as a service to third party entities.
- Provides Controllability and manageability as an owners of the infrastructure.
- Virtualization: Abstracting and slicing physical devices into multiple virtual elements.
- VDC is a virtual infrastructure integrating computing capabilities
- Virtual infrastructures are then employed by tenants to deploy applications on top.
- Coexistence of multiple tenants on top of the same physical infrastructure is achieved.

VDC Mapping [1]

How the requested virtual resources by a VDC are provisioned over the underlying physical ones?

- 1) VM mapping onto physical servers.
- 2) Virtual link mapping onto physical network resources interconnecting these physical servers.

Planning optimization problem of VDC instances on top of a disaggregated DC infrastructure.

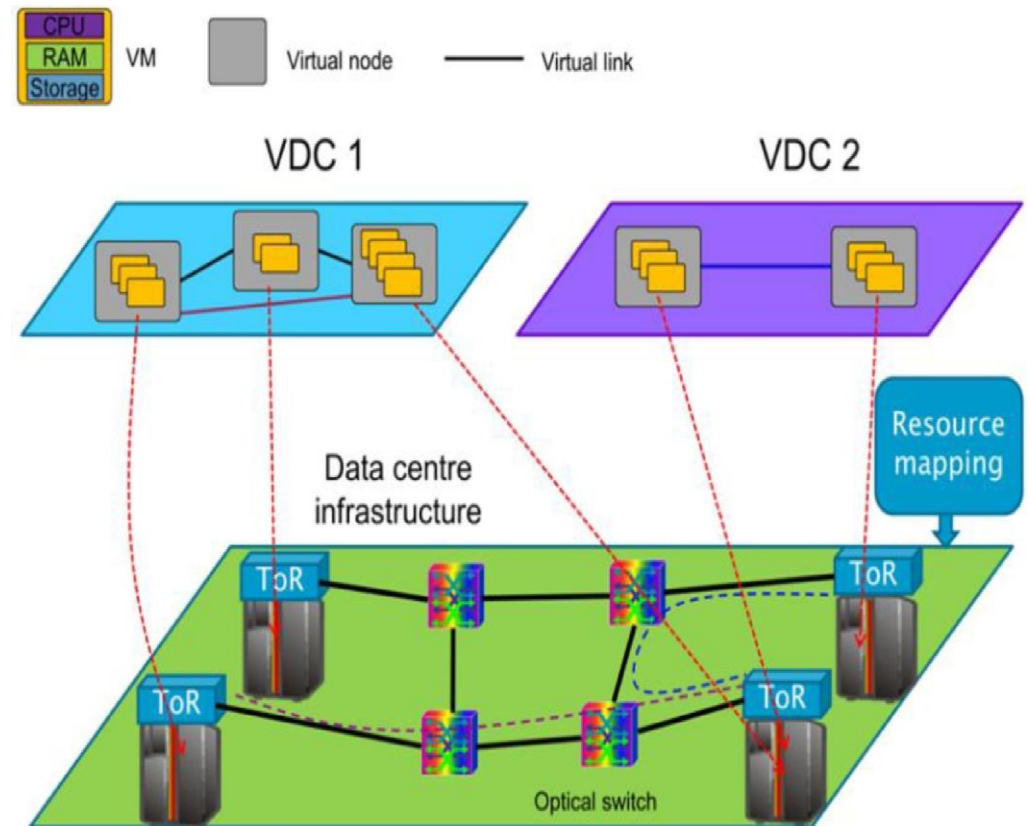


Fig. 2 VDC Mapping Process

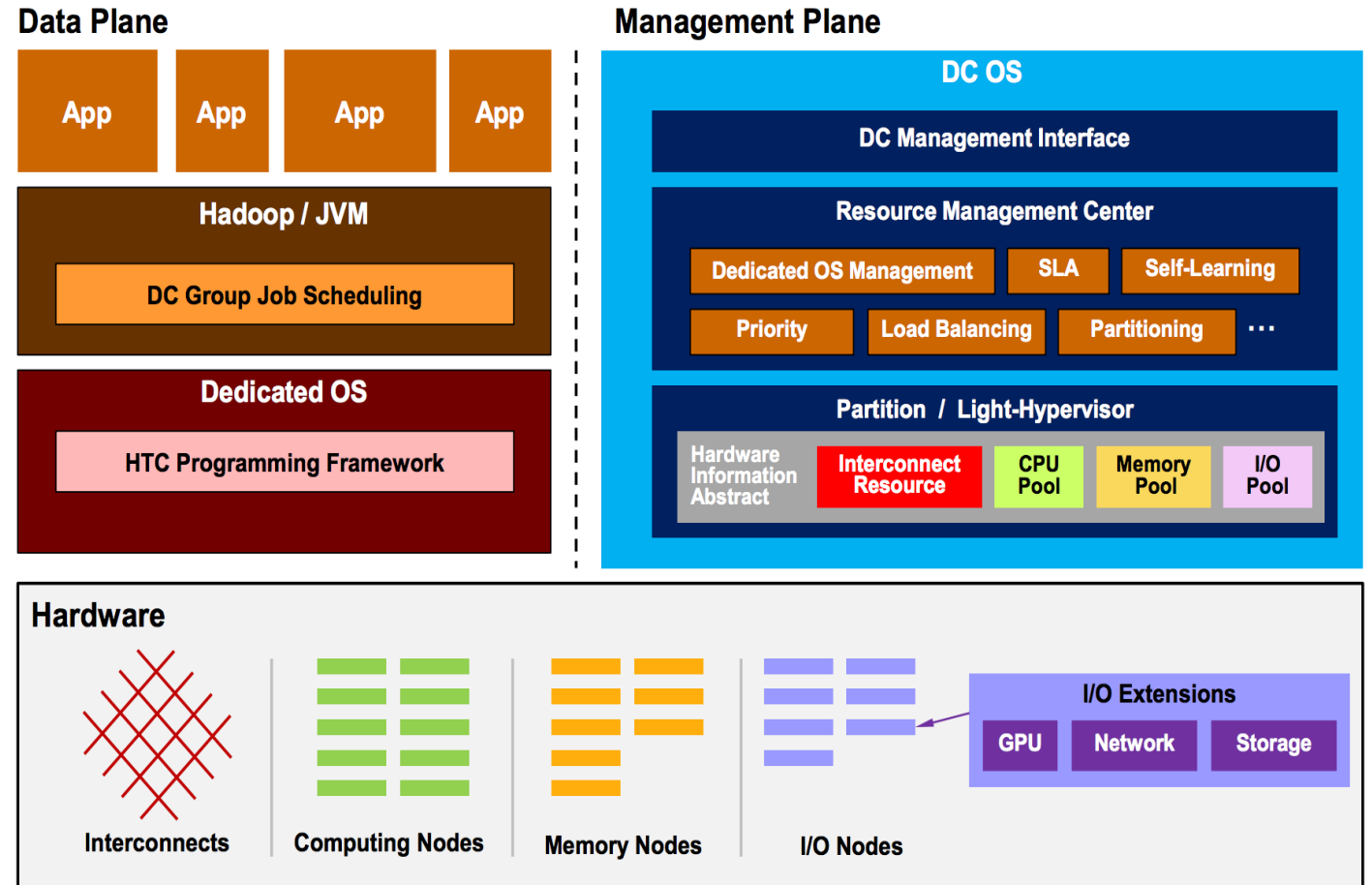
Related Work [1]

- a. **Facebook Open Switching System (FBOSS)**: distributing the switches functionalities across the whole network.
- b. **Open Compute Project (OCP)**: investigate and provide the architecture of future DCs leveraging on the resource disaggregation concept.
- c. **Rack Scale Architecture (RSA) from Intel**: disaggregate compute, network and storage across a DC rack.
- d. **High Throughput Computing Data Center (HTC-DC) Architecture from Huawei** : focuses on a disaggregated DC architecture where blades are interconnected through a high bandwidth optical network fabric.

HTC-DC Architecture [2]

- Hardware resources are organized into different pools.
- Management plane provides monitoring and coordination via DC-OS.
- Data access operations are done in data plane.
- Light hypervisor manages pool abstraction, hardware partitioning etc.

HTC-DC Architecture



3 16

HUAWEI TECHNOLOGIES CO., LTD.



Fig. 3 Huawei HTC-DC Architecture

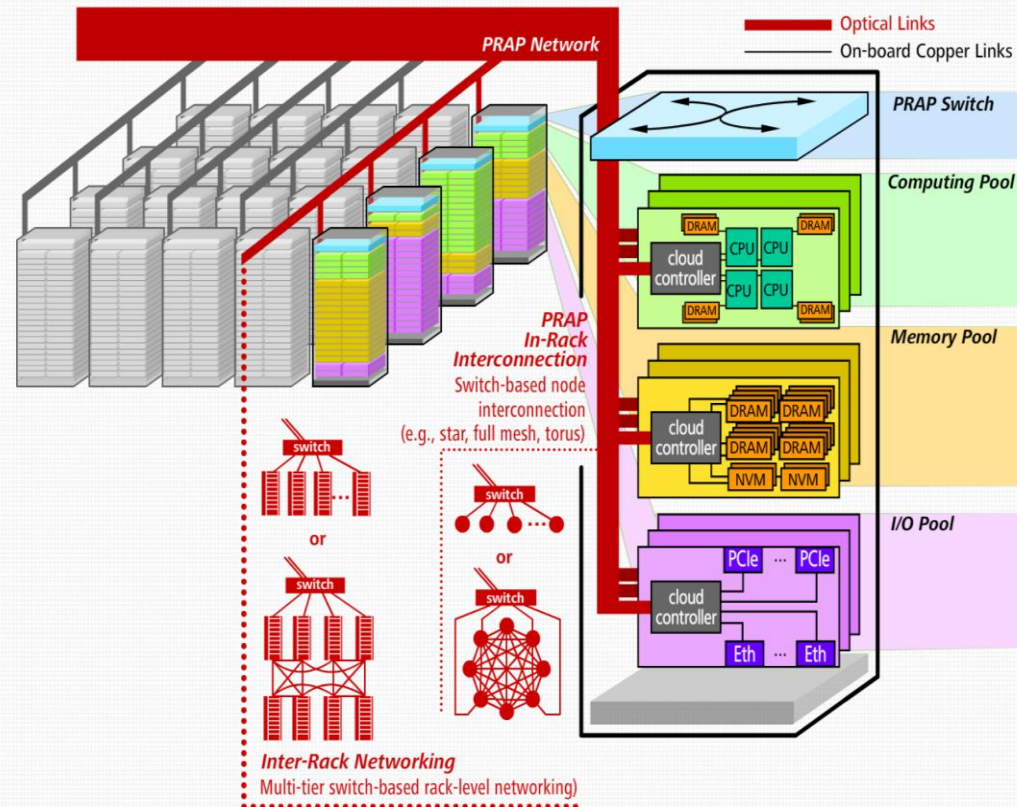
UC DAVIS

HTC-DC Architecture [2]

Pooled Resource Access Protocol (PRAP):

PRAP is implemented in the cloud controller of each node to provide interface-unified interconnects. PRAP supports hybrid flow/packet switching for inter-pool transmission acceleration, with near-to-ns latency.

Hardware Architecture of HTC-DC



17

HUAWEI TECHNOLOGIES CO., LTD.



Fig. 4 Hardware Architecture of Huawei HTC-DC.

HTC-DC Architecture [2]

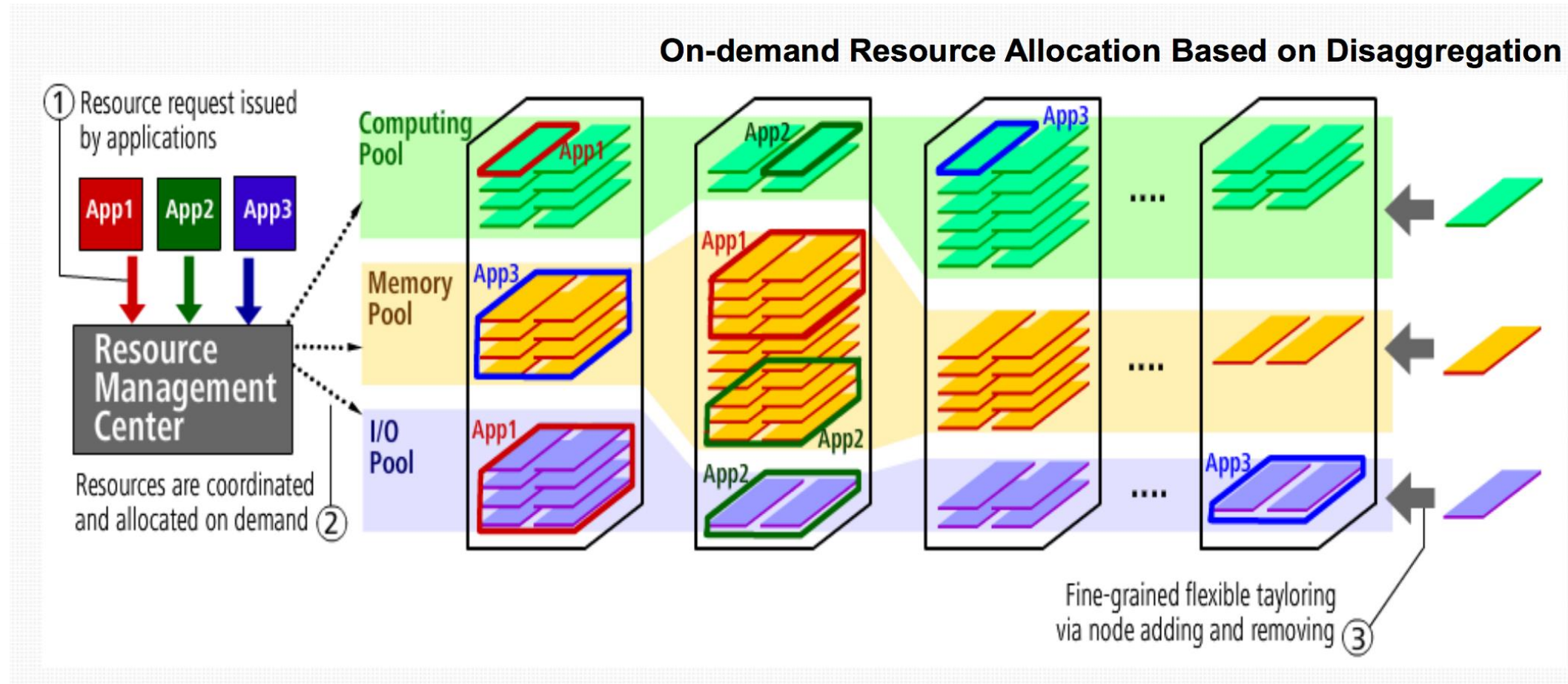


Fig. 5 On demand Resource Allocation Based on Disaggregation

