InterCloud Architecture Framework (ICAF) for Interoperability and Integration

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Outline

- Cloud Computing Architecture research at SNE group (UvA)
- General use cases for Intercloud Architecture
- Related standardisation initiatives: NIST, OGF, IETF
- Intercloud Architectural Framework (ICA/ICAF) components
  - Multi-layer/Layered Cloud Services Model (CSM)
  - Intercloud Control and Management Plane (ICCMP)
  - Intercloud Federation Framework (ICFF)
  - Intercloud Operations Framework (ICAF)
- Abstract Model for Cloud IaaS Provisioning
- Further research and standardisation contribution

System and Network Engineering Group at the University of Amsterdam

- SNE group is primarily a research group but also supports SNE master education
- Main research areas
  - High speed optical networks
    - Recent testbed achieved sub-40Gbps at Amsterdam-CERN link
    - Information modeling for network description
  - Security and generic AAA Authorisation framework (GAAA-AuthZ)
    - Evolving from client/security model to dynamically provisioned services for Cloud and Grids
  - Cloud and Intercloud Architecture, Cloud Security, Cloud Services Provisioning
- New research area on Big Data Infrastructure services and adoption of Cloud based/powered provisioning technologies and models
  - Defining corresponding security models and infrastructure
- Long term research cooperation with SURFnet and GigaPort program in NL
- Re-building own testbed for optical network technologies, Intercloud infrastructures and AAA/Security
- Recent and current projects participation – DataGrid, NextGrid, EGEE, Phosphorus, GEYSERS, GEANT3, NOVI, ENVRI

General use cases for Intercloud Architecture

- Clouds are evolving as a common way of provisioning infrastructure services on-demand
  - In this way, clouds add a new type of services, in addition and on the top of currently existing network based and distributed services
- Intercloud Architecture Framework (ICAF) provides a framework to support provisioning of cloud based project oriented infrastructures on-demand and distributed virtualised applications mobility
  - Hybrid Cloud/Grid e-Science collaborative environment
    - Scientific Data e-Infrastructure for Big Data
  - Enterprise/campus cloud infrastructure evolution and migration/mobility
  - Infrastructure disaster recovery (e.g., Vodafone NL Datacenter Incident – April 2012, Orange multiple DC failures – summer 2012)
    - Data require supporting infrastructure
  - Educational Lab setup in cloud
    - Easy to suspend and deploy when necessary
- *ICAF intends to open Cloud market to more players and rise so-called "cloud curtain"*

InterCloud: Related standardisation activities

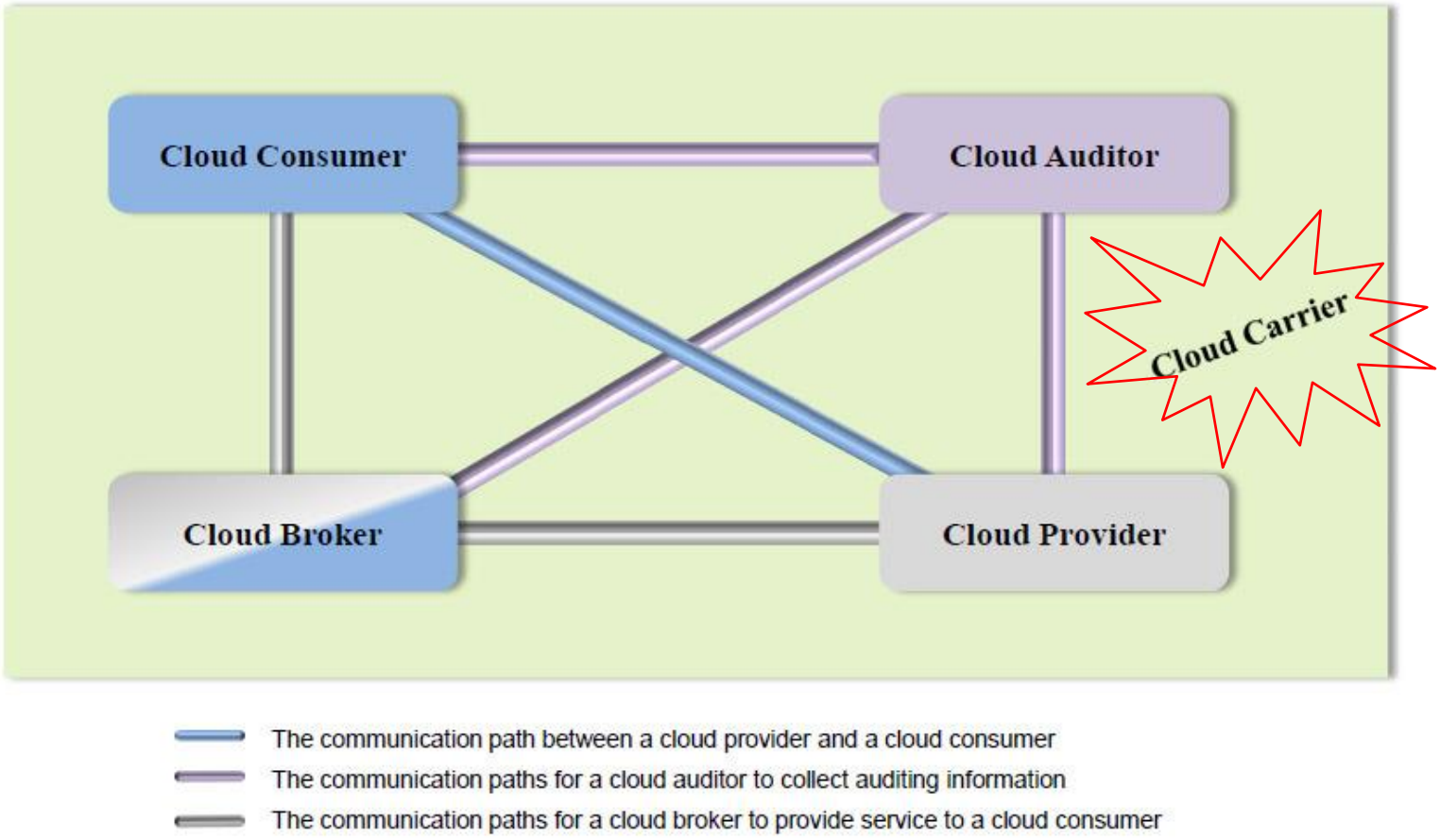
- NIST Cloud definition (NIST SP 800-145), and Cloud Computing Reference Architecture (CCRA), v1.0 (NIST SP 500-292)
- ITU-T Focus Group on Cloud: Technical Report (Part 1 to 7)
  http://www.itu.int/en/ITU-T/focusgroups/cloud/Documents/FG-coud-technical-report.zip
- IEEE - WGs on InterCloud issues and Cloud Profiles
  - IEEE ICWG/2302 WG - Intercloud WG (ICWG) Working Group
    http://standards.ieee.org/develop/wg/ICWG-2302_WG.html
- OGF ISOD-RG
  - BCP on existing on-demand network and cloud infrastructure resources provisioning systems (including GEYSERS)
- IETF Internet Drafts
  - Cloud Reference Framework. Internet Draft, by B. Khasnabish, J. Chu, S. Ma, Y. Meng, N. So, P. Unbehagen, M. Morrow, M. Hasan, Y. Demchenko
    http://tools.ietf.org/html/draft-khasnabish-cloud-reference-framework-03.txt
  - Cloud Service Broker, Internet Draft by Shao Weixiang, Hu Jie, Bhumip Khasnabish.
    http://tools.ietf.org/html/draft-shao-opsawg-cloud-service-broker-03.txt

NIST Cloud definition – SP 800-145

Draft SP 800-145 A NIST Definition of Cloud Computing (published Nov 2011)
http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf

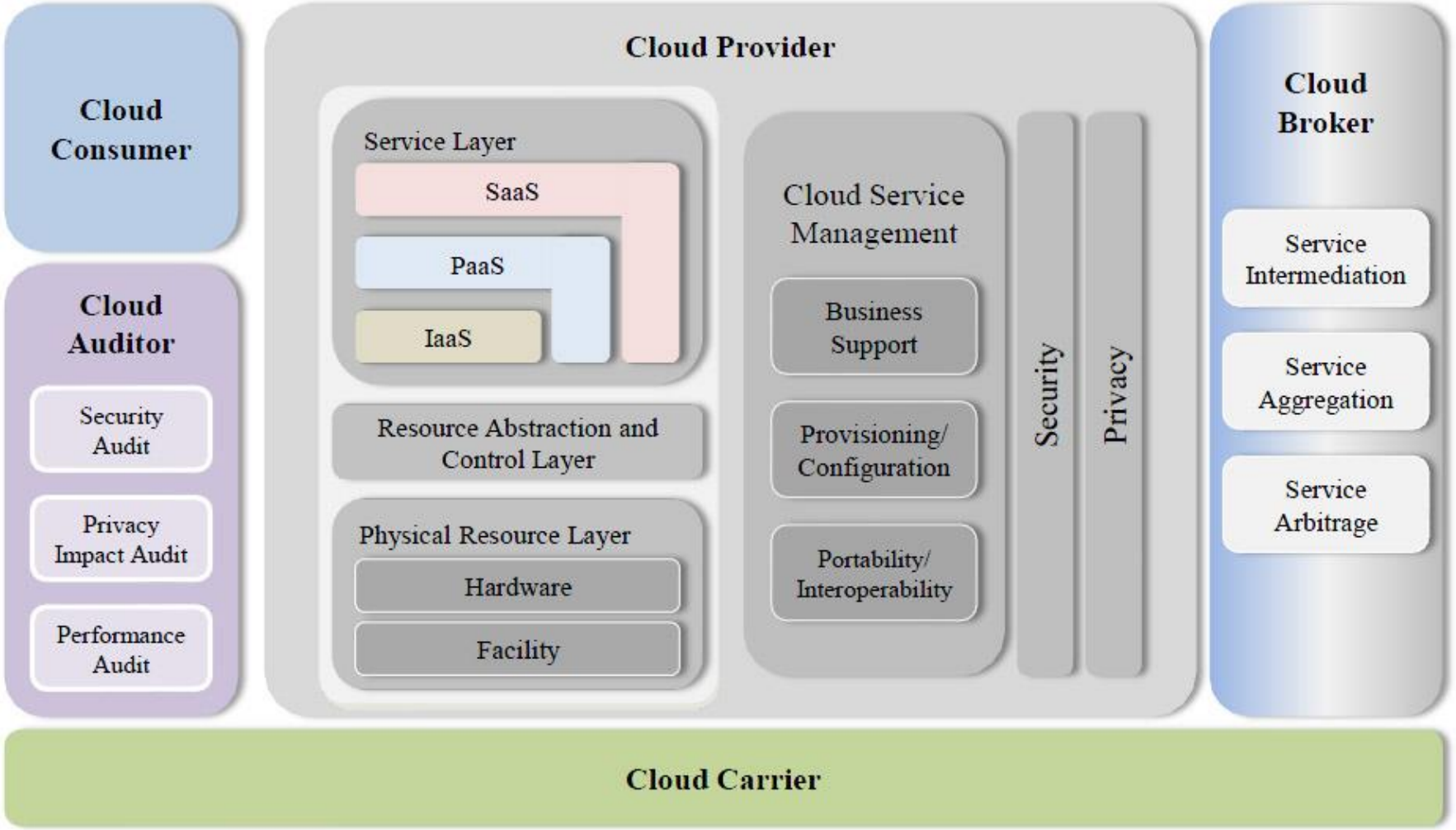
- Five essential clouds characteristics
  - On-demand self-service
  - Broad network access
  - Resource pooling
  - Rapid elasticity
  - Measured Service
- 3 service/provisioning models
  - Software as a Service (SaaS)
  - *Platform as a Service (PaaS)*
  - Infrastructure as a Service (IaaS)
- 4 deployment models
  - Public cloud
  - Private cloud
  - Community cloud
  - Hybrid cloud

NIST Cloud Computing Reference Architecture (CCRA) 2.0 - Main Roles



- Cloud Carrier as a role to accommodate telco's interests

NIST Cloud Computing Reference Architecture (CCRA) 2.0 – Consolidated View



Work on I-Draft "Cloud Reference Framework" (Version 0.3)

http://tools.ietf.org/html/draft-khasnabish-cloud-reference-framework-03.txt

B. Khasnabish
(ZTE USA)
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Y.Demchenko
University of Amsterdam

Version 0.3 – 29 June 2012
Version 0.4 – December 2012
Version 0.5 – Summer 2013
(To be considered)

Intercloud Architecture - Requirements

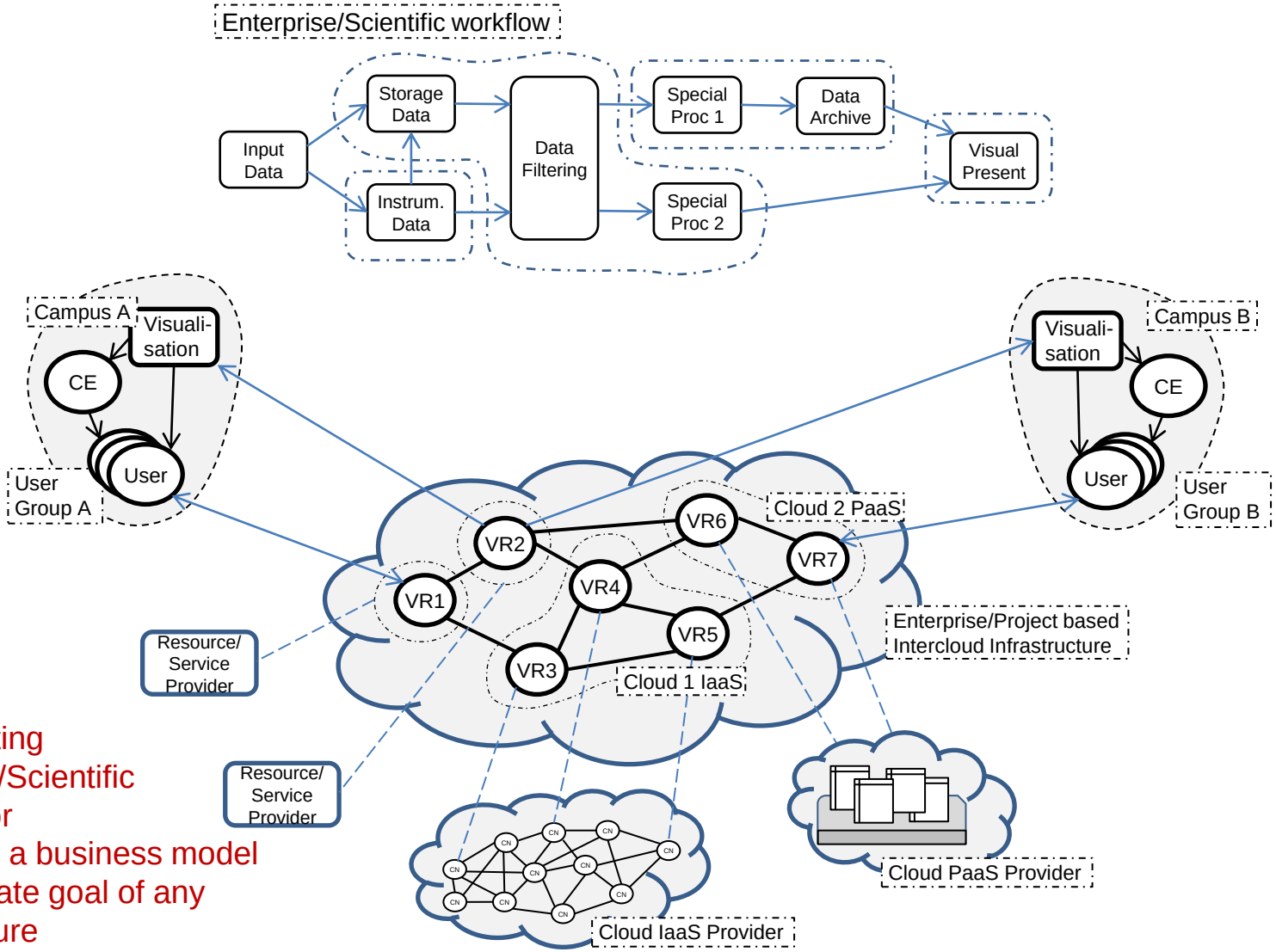
Intercloud Architecture (ICA) should address interoperability and integration of different cloud service platforms provided by multiple cloud providers, including integration with legacy campus/enterprise infrastructure

- Be compatible and provide multi-layer integration of existing cloud service models – IaaS, PaaS, SaaS and Apps clouds
- Facilitate interoperable and measurable intra-provider infrastructures
- Provide a framework for heterogeneous inter-cloud federation
- Support/provide Intercloud Control and Management Plane functionality for performance critical cloud services and network integration
- Support intra- and inter-cloud *network infrastructure* provisioning with controlled performance and QoS (as NaaS service model)
- Support existing Cloud Provider operational and business models and provide a basis for new forms of services provisioning and operation
  - Support *provider side federation (for resources sharing)* and *customer/broker side federation for multi-provider infrastructure integration*

InterCloud Architecture components

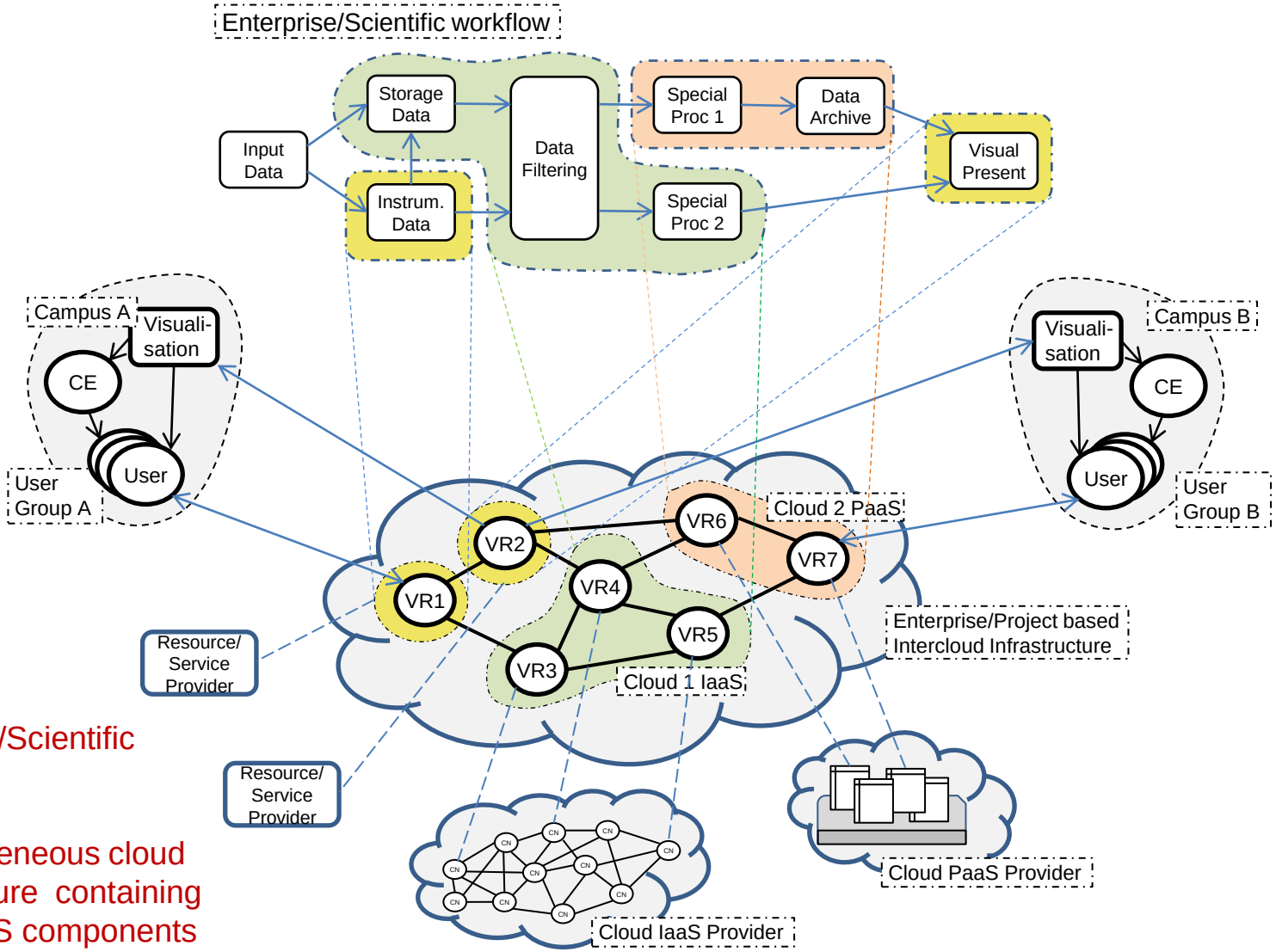
- Multi-layer Cloud Services Model (CSM)
  - Combines IaaS, PaaS, SaaS into multi-layer model with inter-layer interfaces
  - Including interfaces definition between cloud service layers and virtualisation platform
- InterCloud Control and Management Plane (ICCMP)
  - Allows signaling, monitoring, dynamic configuration and synchronisation of the distributed heterogeneous clouds
  - Including management interface from applications to network infrastructure and virtualisation platform
- InterCloud Federation Framework (ICFF)
  - Defines set of protocols and mechanisms to ensure heterogeneous clouds integration at service and business level
  - Addresses Identity Federation, federated network access, etc.
- InterCloud Operations Framework (ICOF)
  - RORA model: Resource, Ownership, Role, Action
    - RORA model provides basis for business processes definition, SLA and access control
  - Broker and federation operation

General use case for infrastructure provisioning: Workflow => Logical (Cloud) Infrastructure (1)



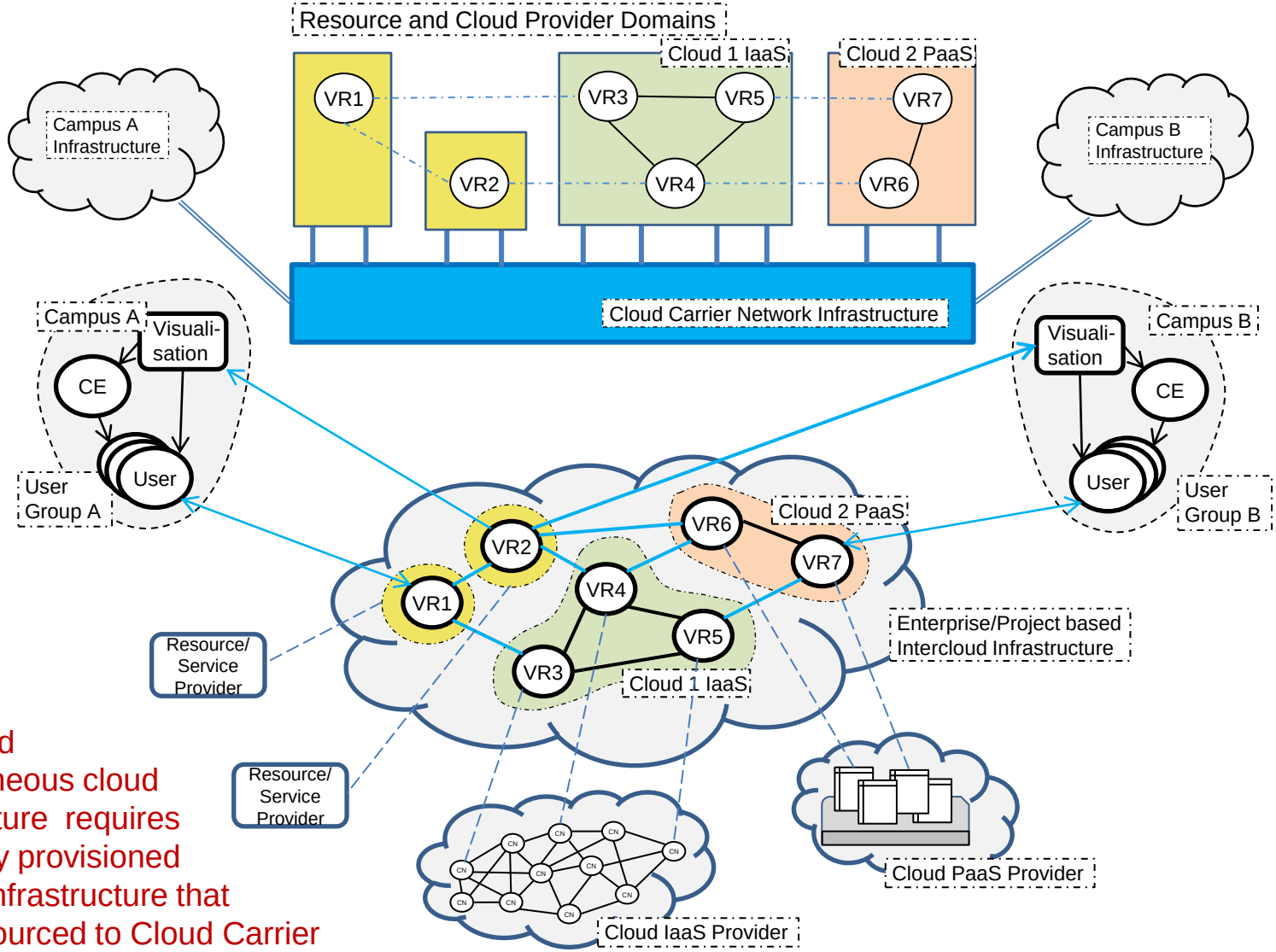
Implementing Enterprise/Scientific workflow or supporting a business model is an ultimate goal of any infrastructure

General use case for infrastructure provisioning: Workflow => Logical (Cloud) Infrastructure (2)



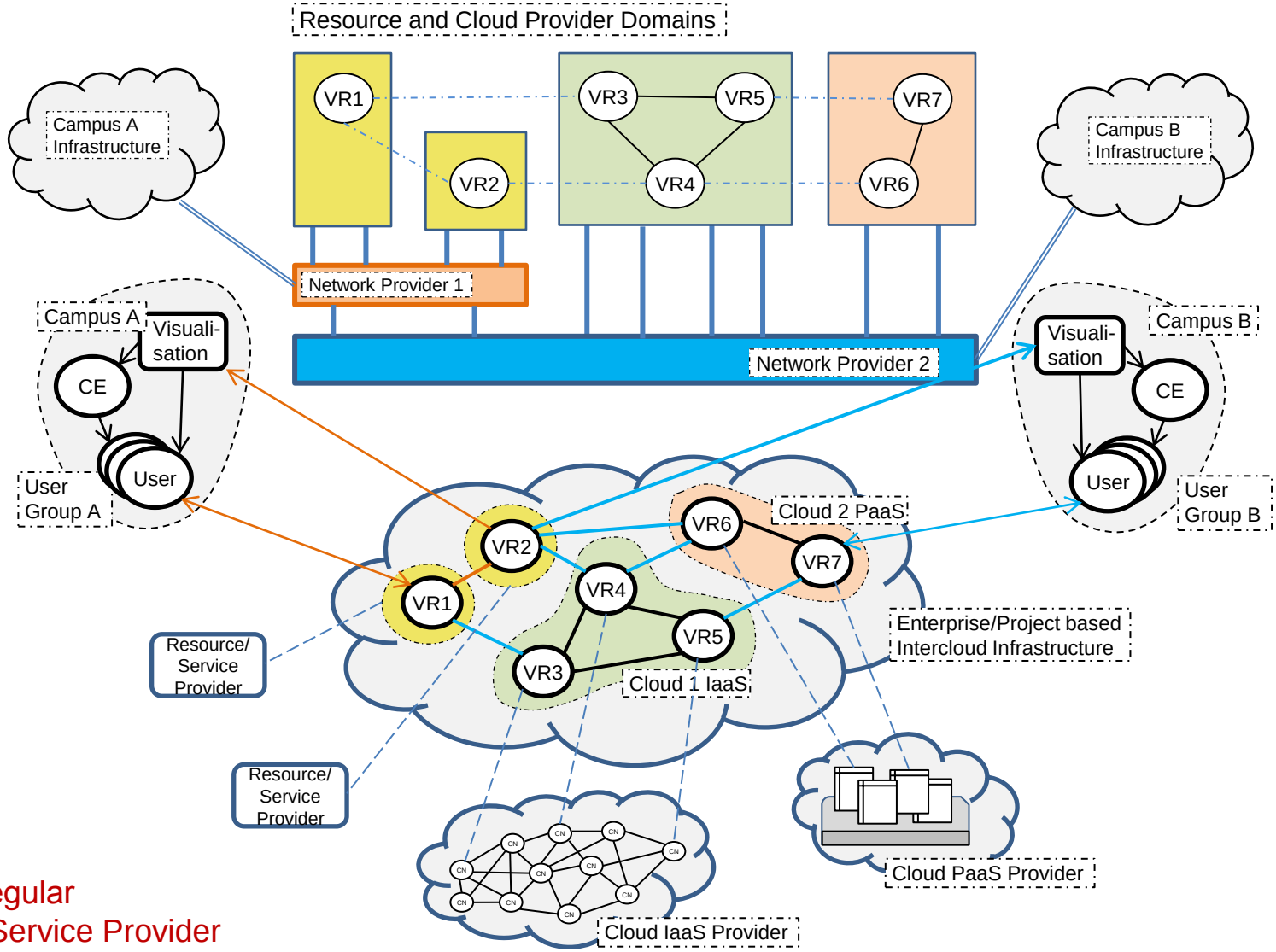
Enterprise/Scientific workflow
Is mapped
to heterogeneous cloud infrastructure containing IaaS, PaaS components

General use case for infrastructure provisioning: Logical Infrastructure => Network Infrastructure (1)

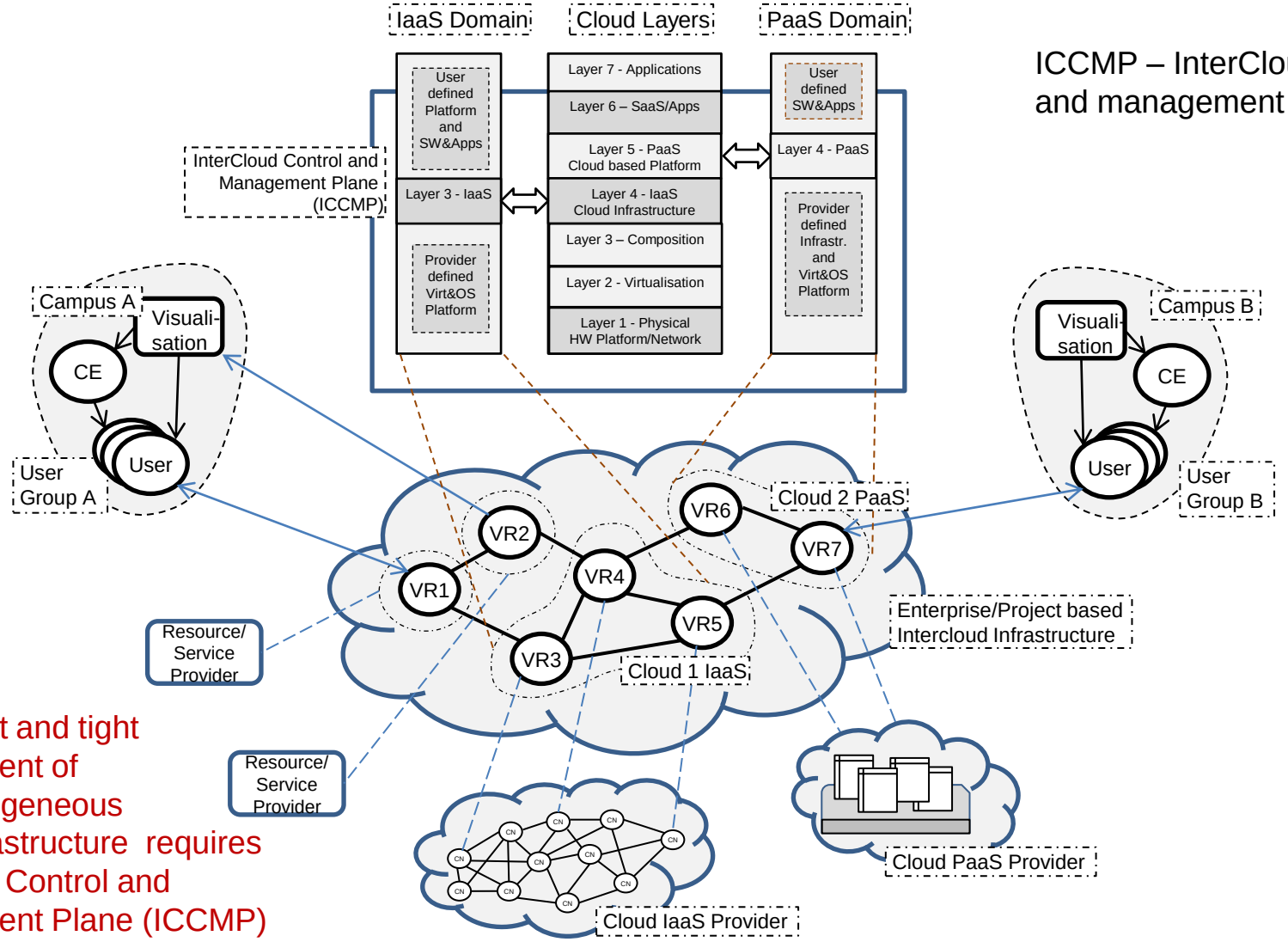


Distributed heterogeneous cloud infrastructure requires separately provisioned network infrastructure that Can outsourced to Cloud Carrier

General use case for infrastructure provisioning: Logical Infrastructure => Network Infrastructure (2)



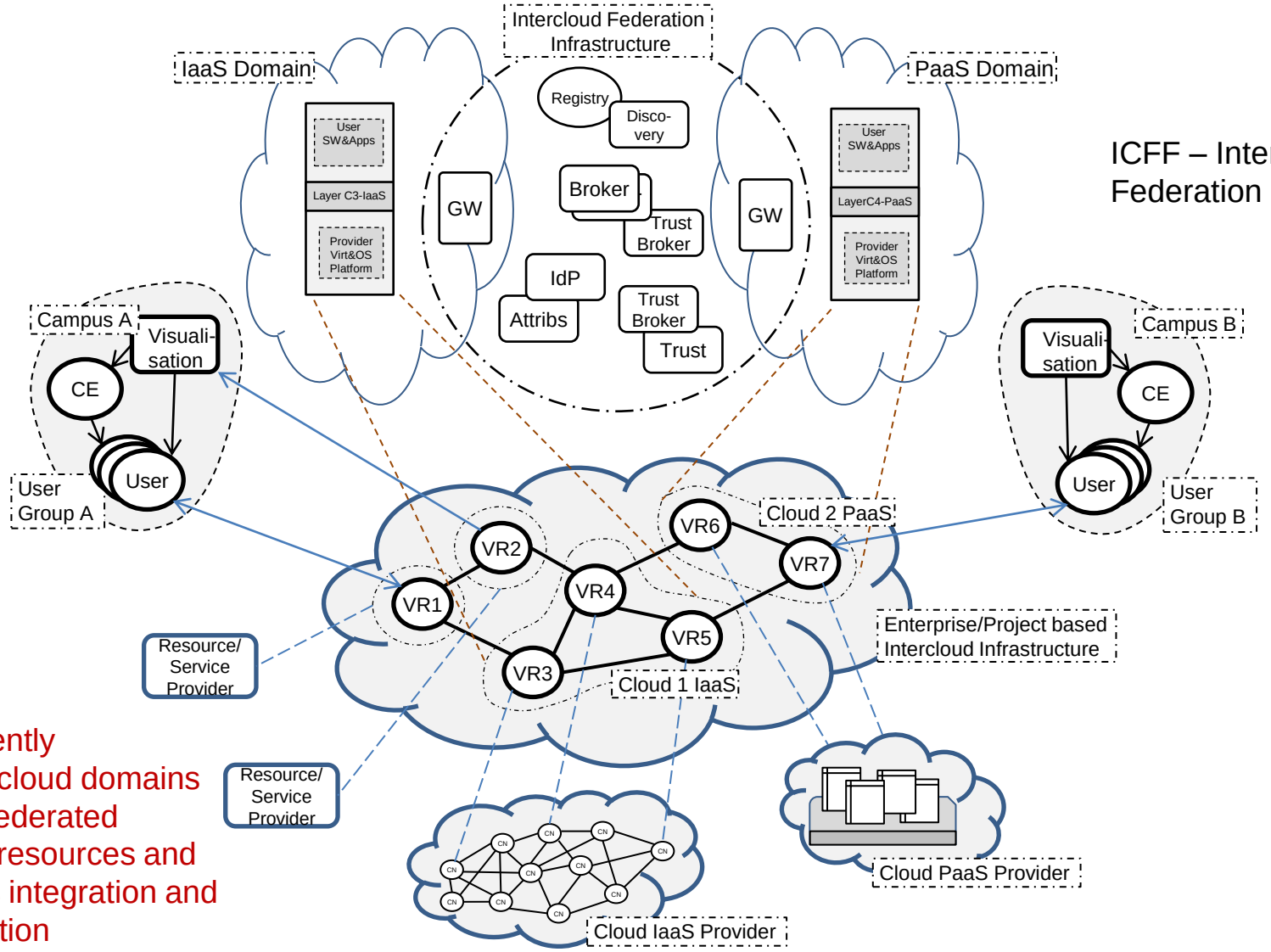
Intercloud Applications Interaction (1) - ICCMP



ICCMP – InterCloud Control and management Plane

Consistent and tight management of the heterogeneous cloud infrastructure requires Intercloud Control and Management Plane (ICCMP)

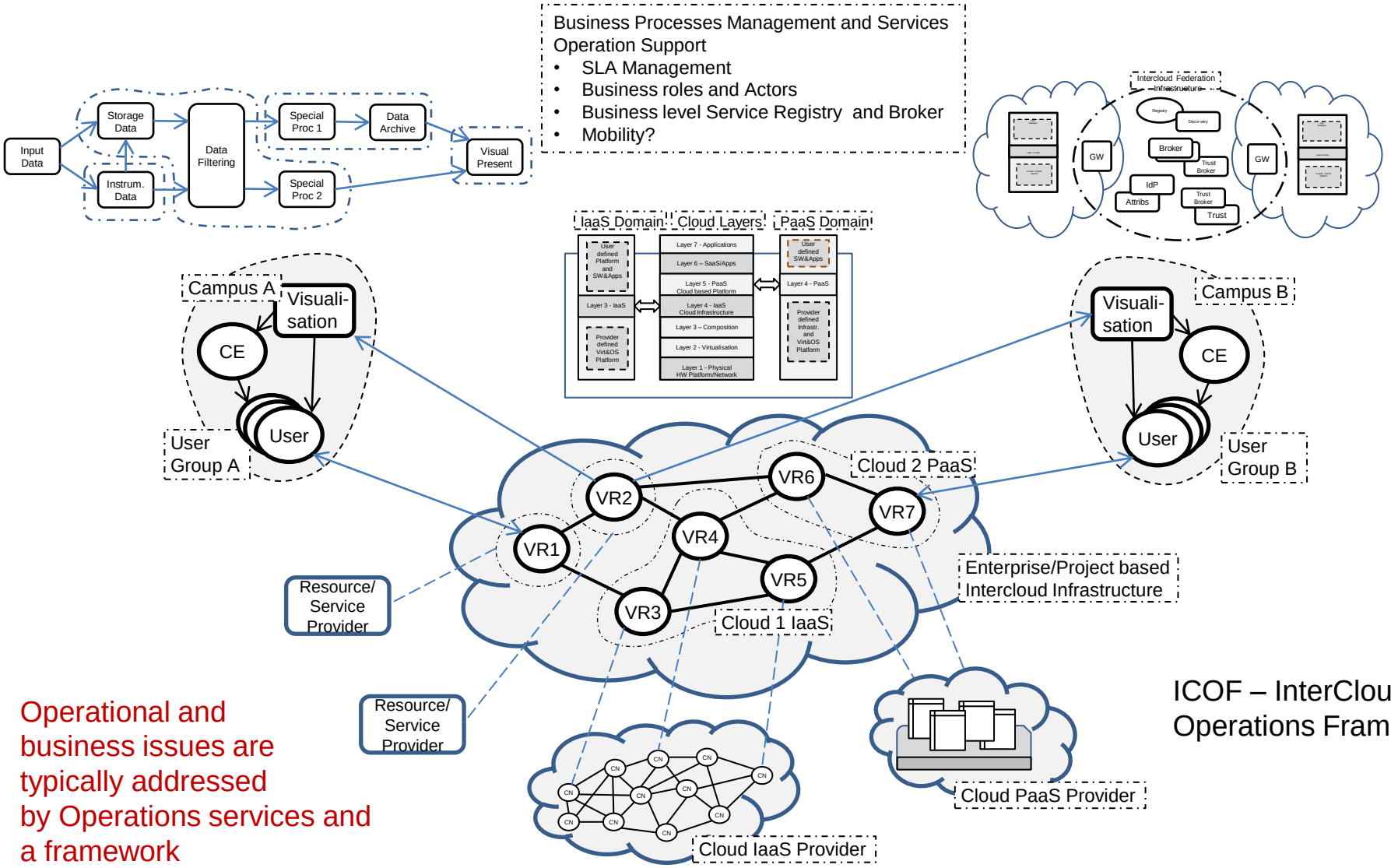
Intercloud Applications Interaction (2) - ICFF



ICFF – InterCloud Federation Framework

Independently managed cloud domains may use federated model for resources and processes integration and interoperation

Intercloud Applications Integration (3) - ICOF



Operational and business issues are typically addressed by Operations services and a framework

ICOF – InterCloud Operations Framework

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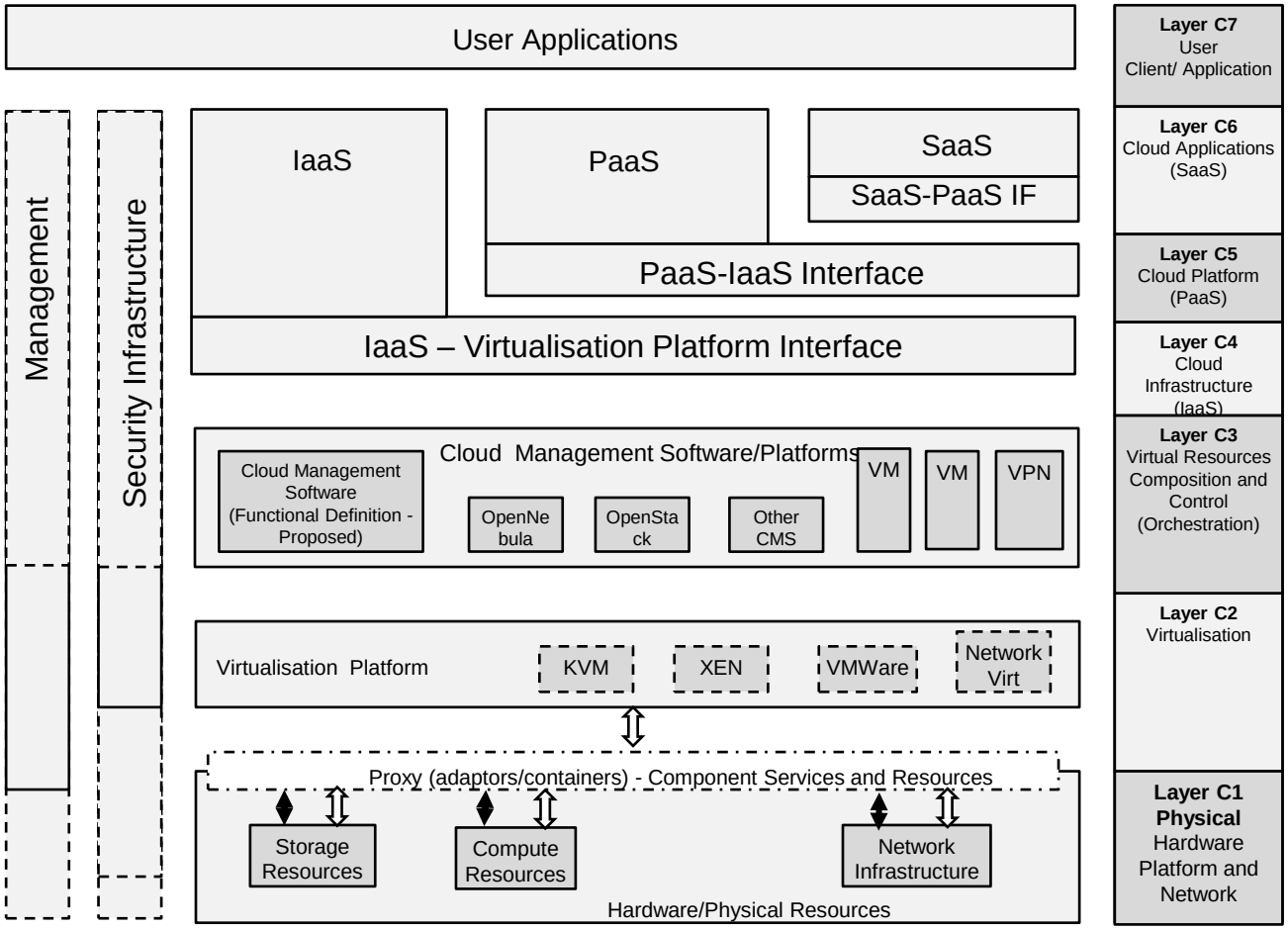
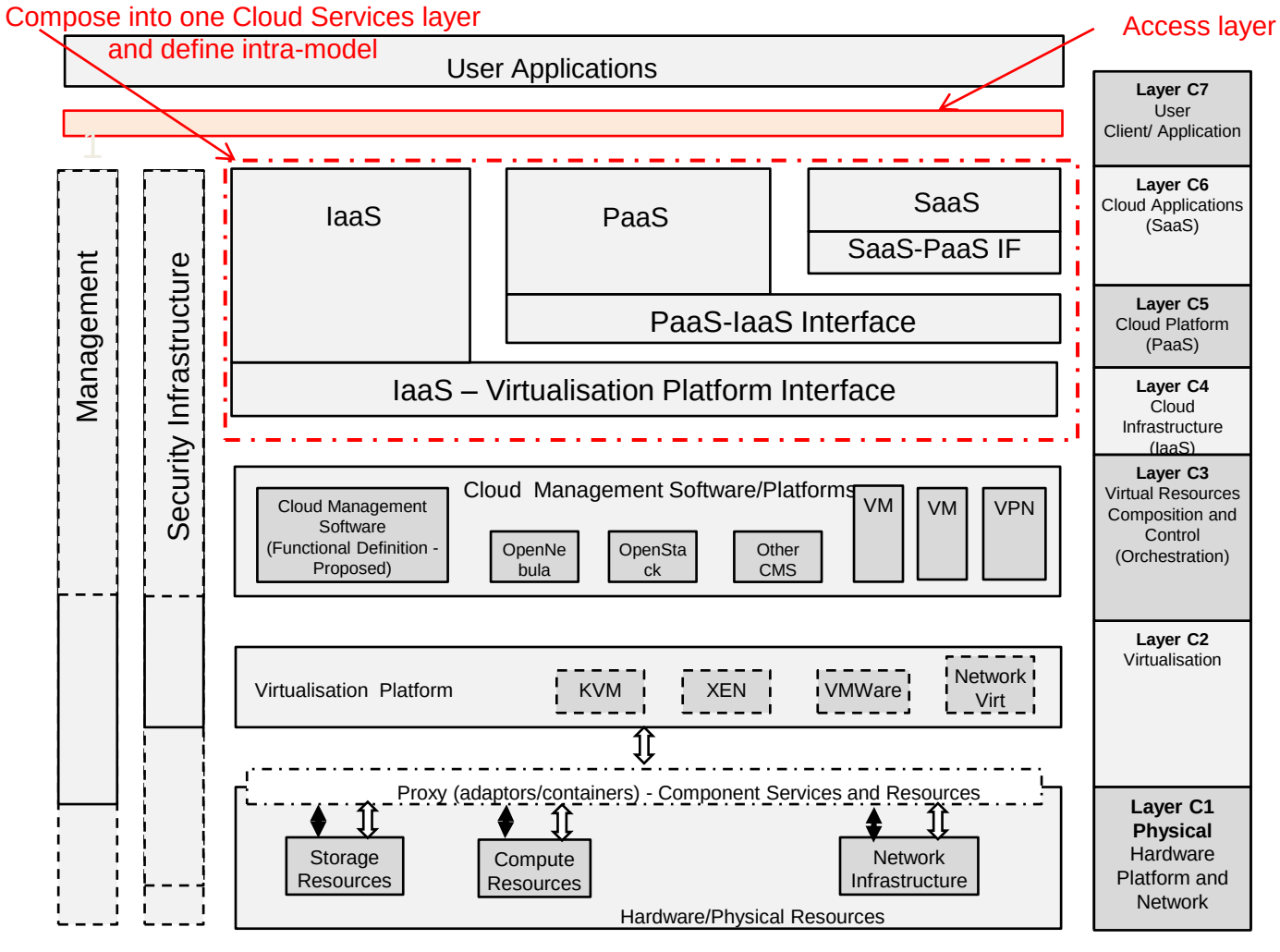
Multilayer Cloud Services Model (CSM)



CSM layers

(C7) User Client/Application
(C6) Cloud Application (SaaS)
(C5) Cloud Platform (PaaS)
(C4) Cloud Infrastructure (IaaS)
(C3) Virtual Resources Composition and Orchestration
(C2) Virtualisation Layer
(C1) Hardware platform and dedicated network infrastructure

Multilayer Cloud Services Model (CSM) – In development



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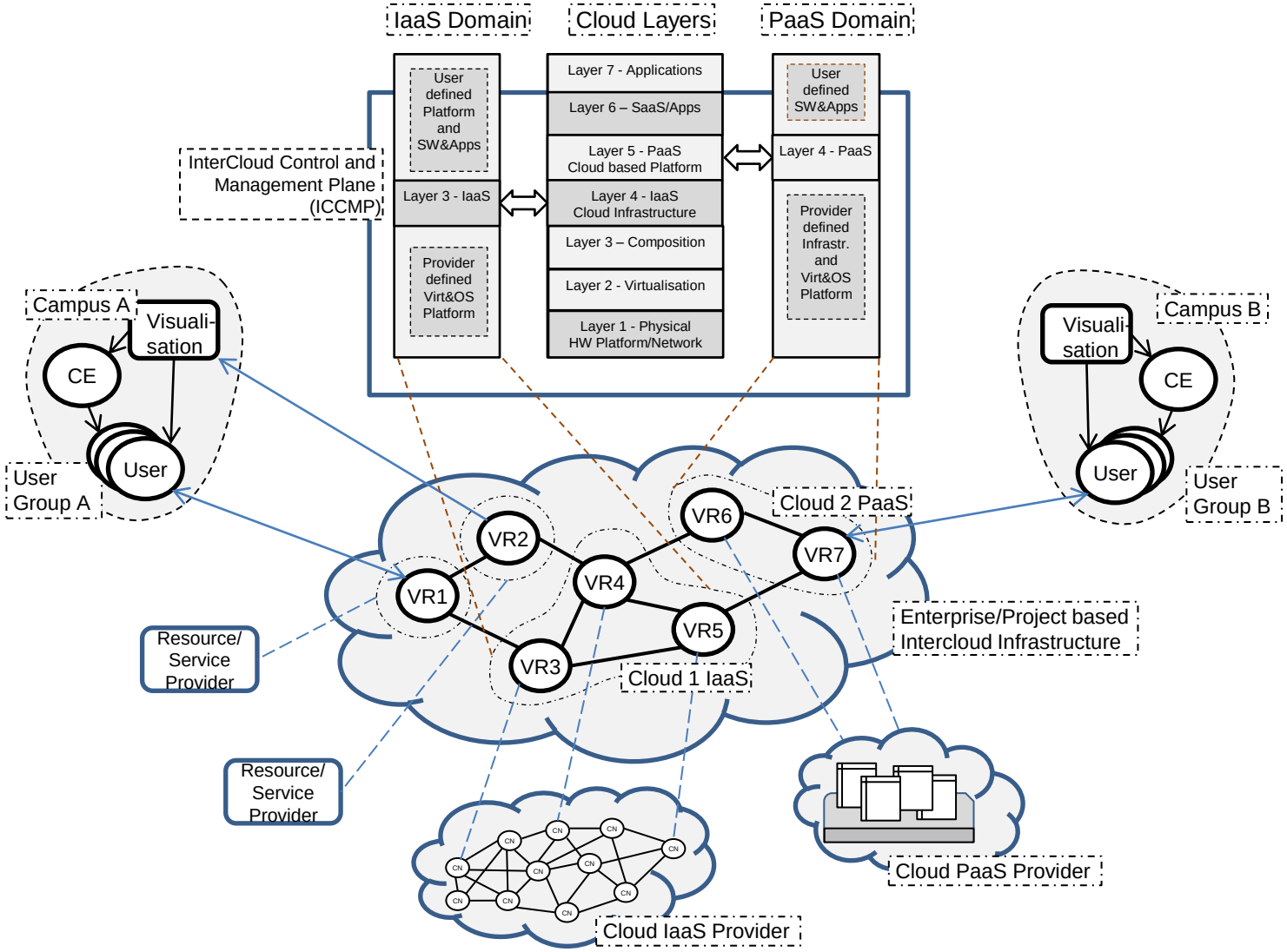
Control/ Mngnt Links

Data Links

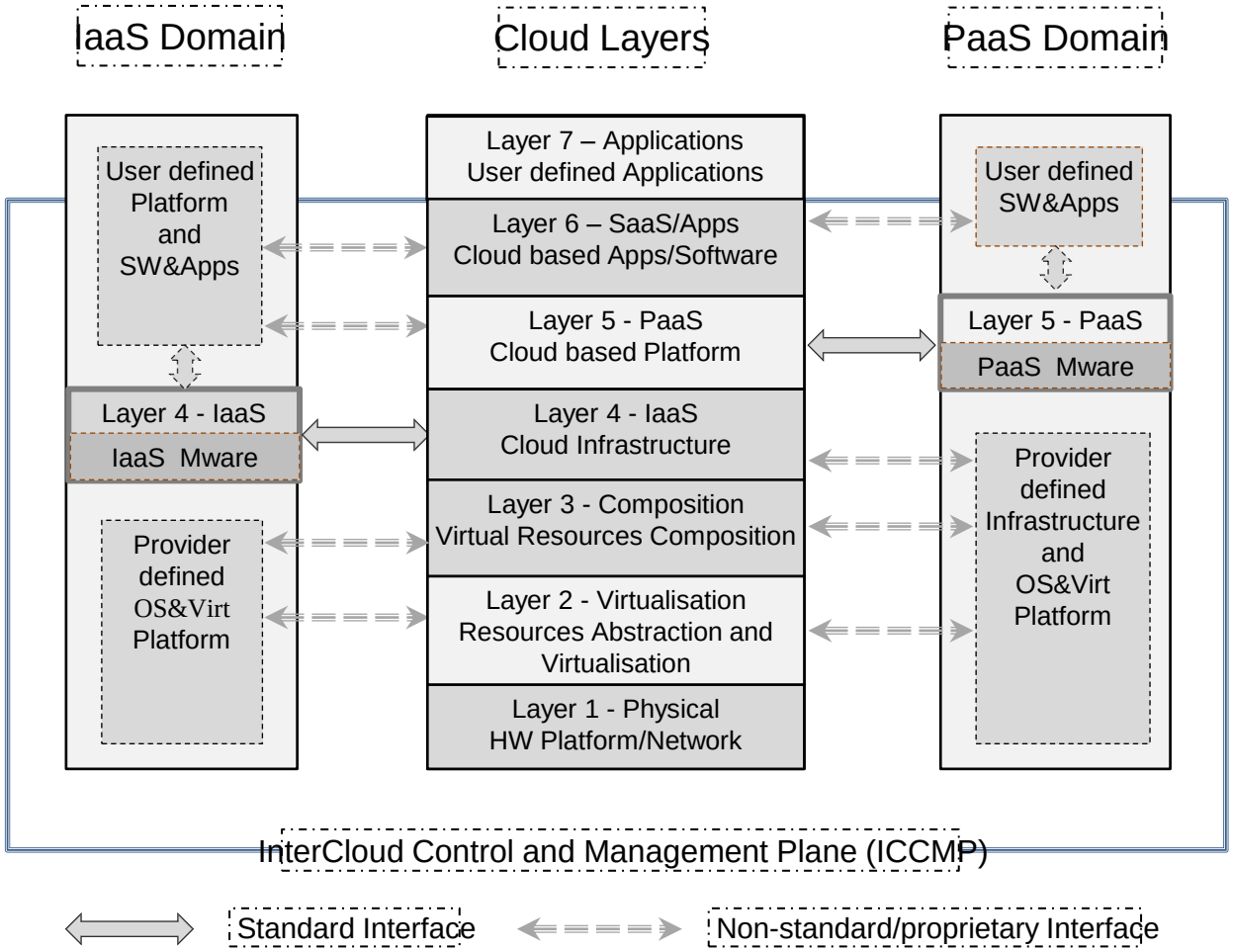
Intercloud Control and Management (1)

- Supports messages delivery/routing, signaling, monitoring, dynamic configuration and synchronisation between the distributed heterogeneous cloud instances
- Includes management interfaces from upper layers and applications to network infrastructure and virtualisation platform (virtualised resources)
- Layer 1 - Layer 4 interfaces are being developed and prototyped in the framework of the GEYSERS project

Intercloud Control and Management (2)



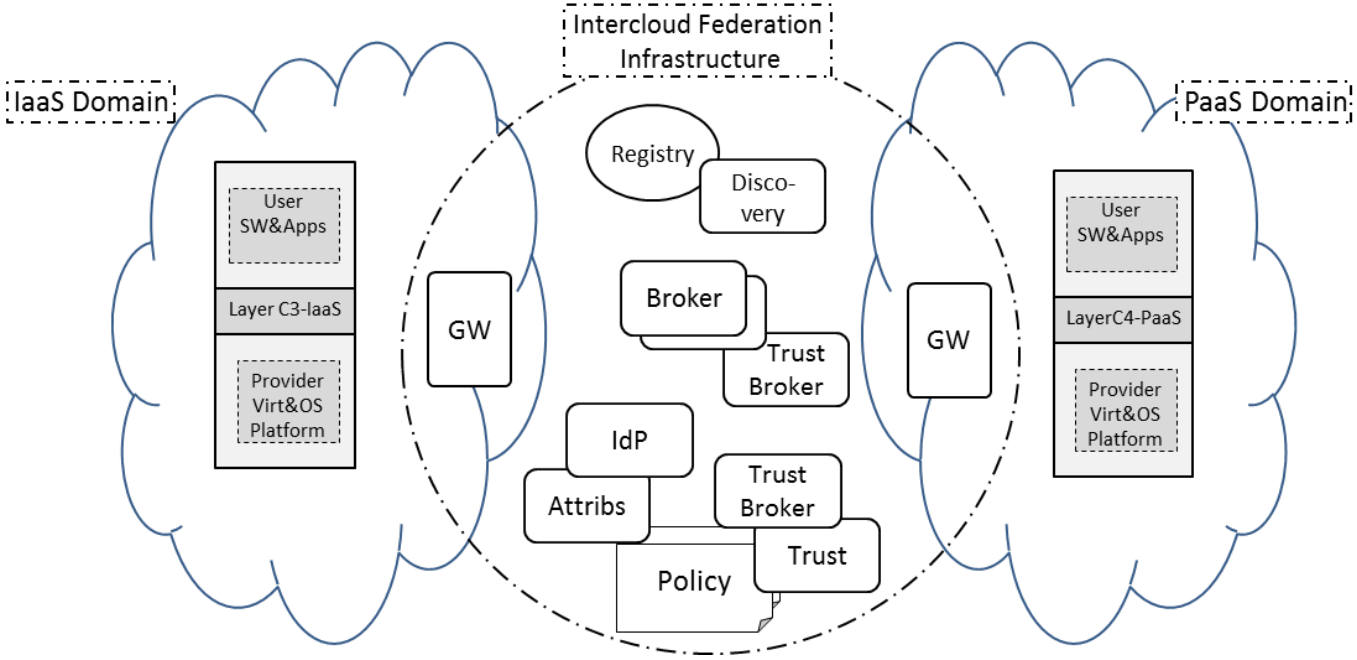
Intercloud Control and Management (3)



Intercloud Control and Management (4)

- Allows signaling, monitoring, dynamic configuration and synchronisation of the distributed heterogeneous clouds
- Including management interface from applications to network infrastructure and virtualisation platform
- Main functional components include
  - Cloud Resource Manager
  - Network Infrastructure Manager
- Possible ICCMP Interfaces include
  - Message routing
  - Signaling
  - Control
  - Management
  - Monitoring
  - Location

InterCloud Federation Framework (1)

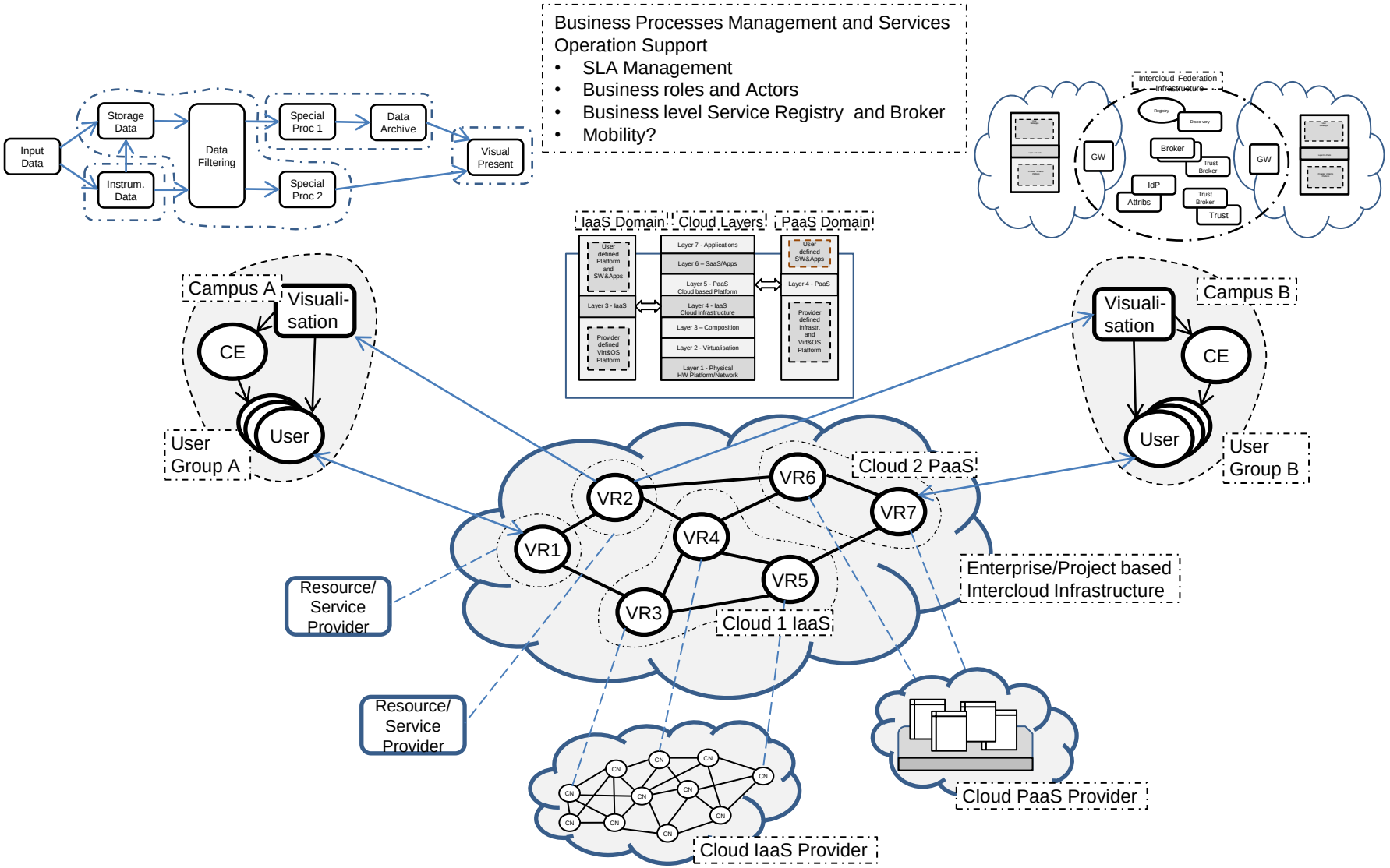


- All inter-services interactions involve 3rd party actor: Registry, Broker and gateways
- Requires previously established relations/contracts and trust relations – direct or via trusted broker
- Dynamic trust establishing mechanisms required for dynamic inter-cloud federation

InterCloud Federation Framework (2)

- Defines set of protocols and mechanisms to ensure heterogeneous clouds integration at service and business level
- Addresses Identity Federation, federated network access, etc.
- Main functional components include
  - Service and Trust brokers
  - Intercloud gateway including attribute/namespace translator
    - Attribute/namespace resolver
  - Service Registry
  - Service discovery service
  - Identity provider
  - Trust manager/router
- Possible ICFF Interfaces
  - Naming, Addressing and Translation (if/as needed)
  - Publishing
  - Discovery
  - Attributes management
  - Trust/key management

InterCloud Operations Framework (1)



InterCloud Operations Framework (2)

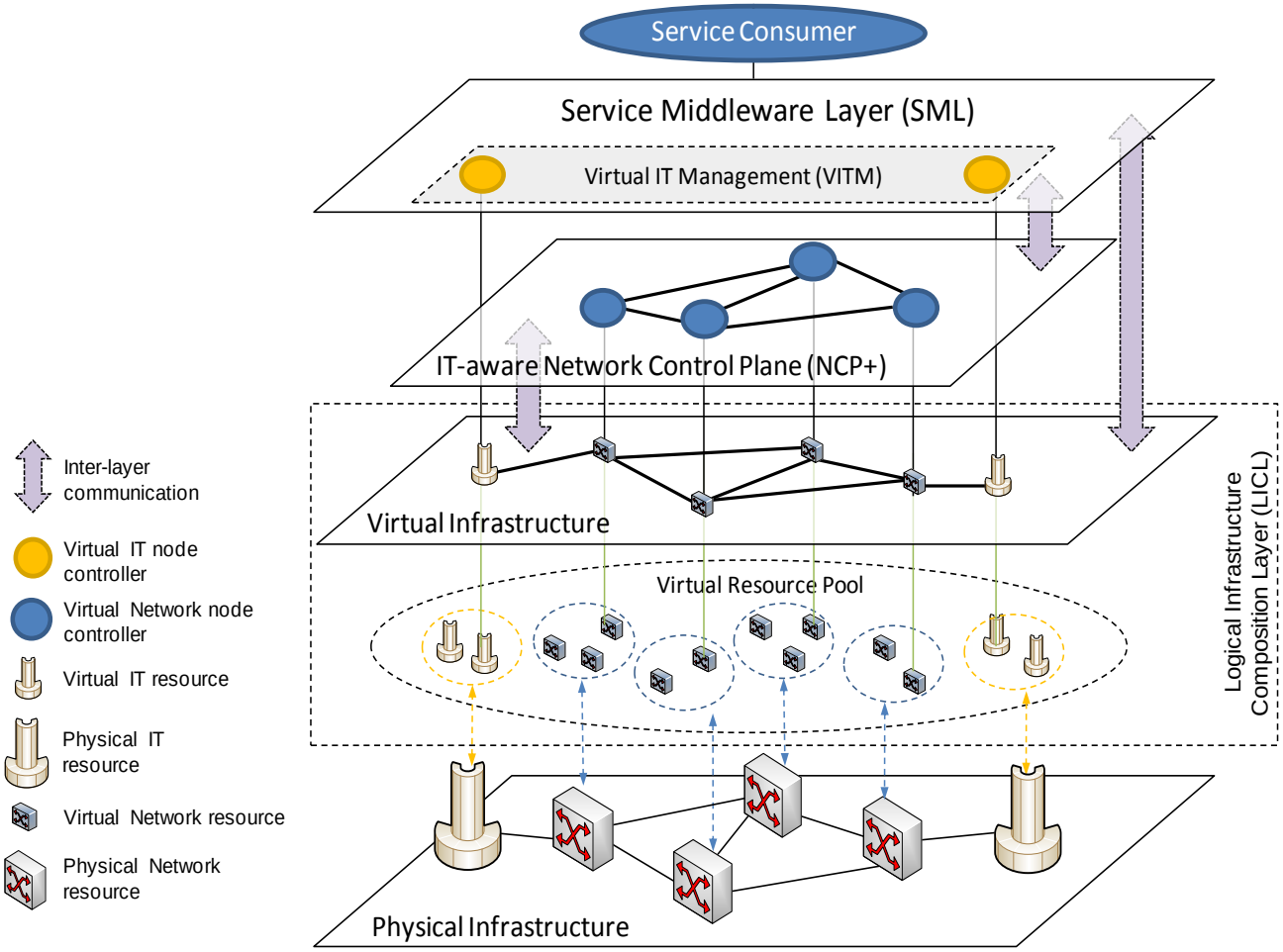
- Defines the main roles and actors
  - RORA model: Resource, Ownership, Role, Action
    - Defined in the GEYSERS project to address infrastructure services virtualisation
    - Provides basis for business processes definition, SLA management and access control policy definition
- Broker and Federation operation
- Main functional components include
  - Cloud Service Provider, Cloud Operator, Cloud (physical) Resource provider, Cloud Carrier
  - Service Registry
  - Service Broker
- Possible ICOF Interfaces
  - Provisioning, Deployment, Decommissioning/Termination
  - SLA management and negotiation
  - Services Lifecycle management
  - Services deployment

Main Actors in Cloud/InterCloud Architecture

- Cloud Service Provider
- Intercloud (Cloud Service) Operator
- Cloud Customer
- Cloud User
- Cloud Carrier
- Cloud Broker
- Cloud Auditor
- Cloud Resource Provider
- Physical Resource Provider
  - Can also be a “fixed” resources provider

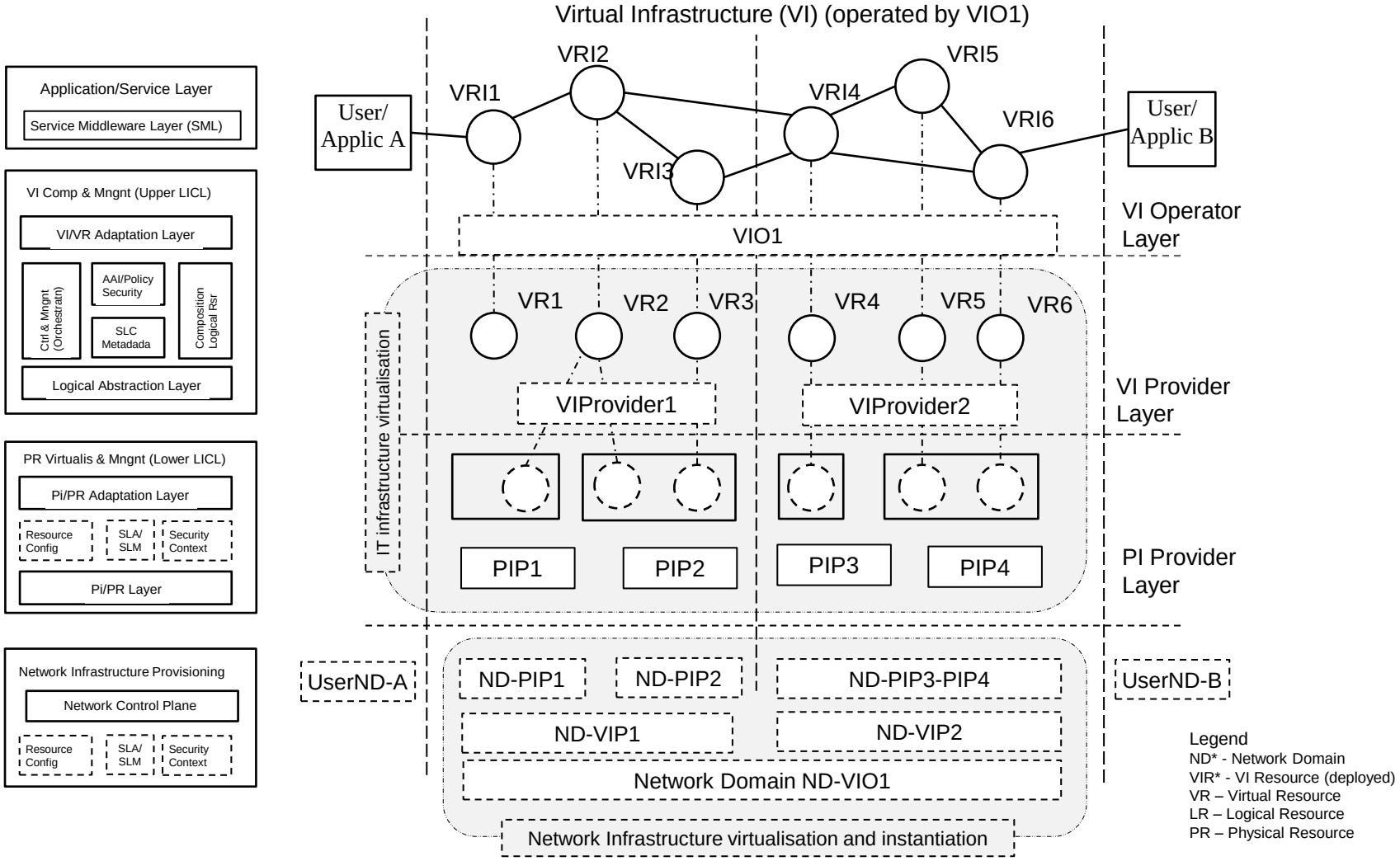
Ownership/Management model needs to be applied to these actors using extended RORA model

Implementation: GEYSERS Project Layered Architecture – CSM and ICCMP



- Developed and implemented in the GEYSERS project http://www.geysers.eu/

Abstract (Cloud) IaaS Provisioning Model



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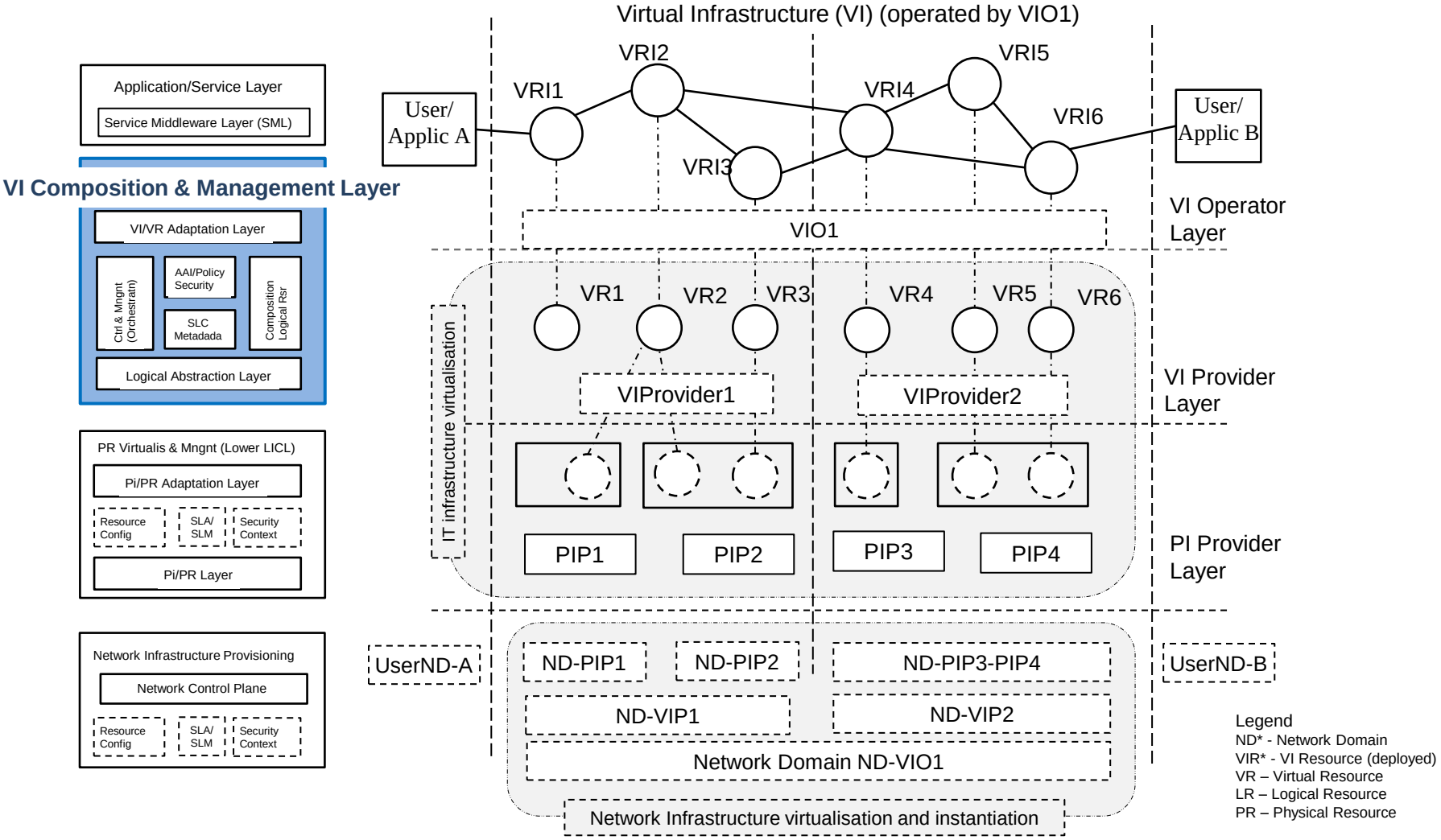

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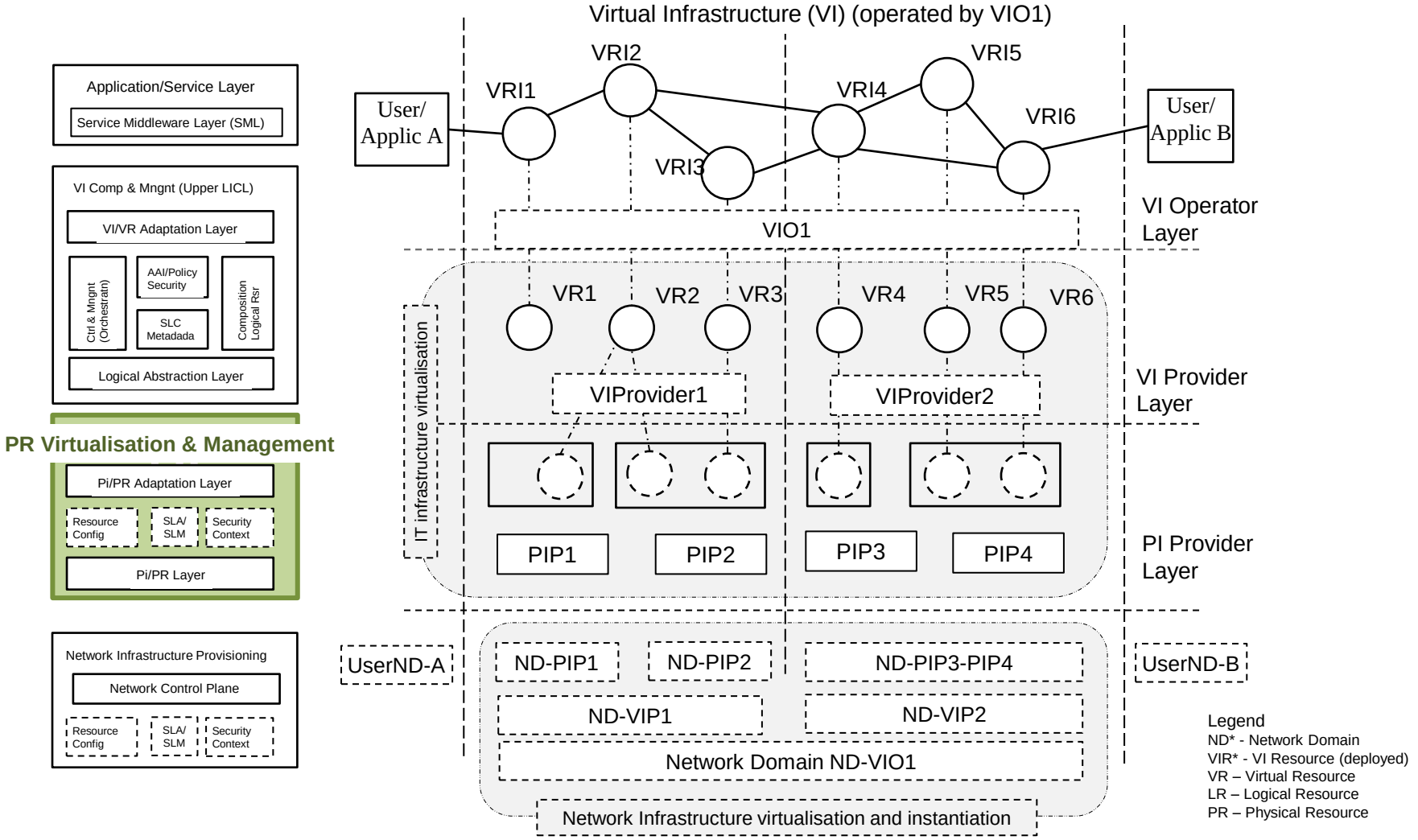

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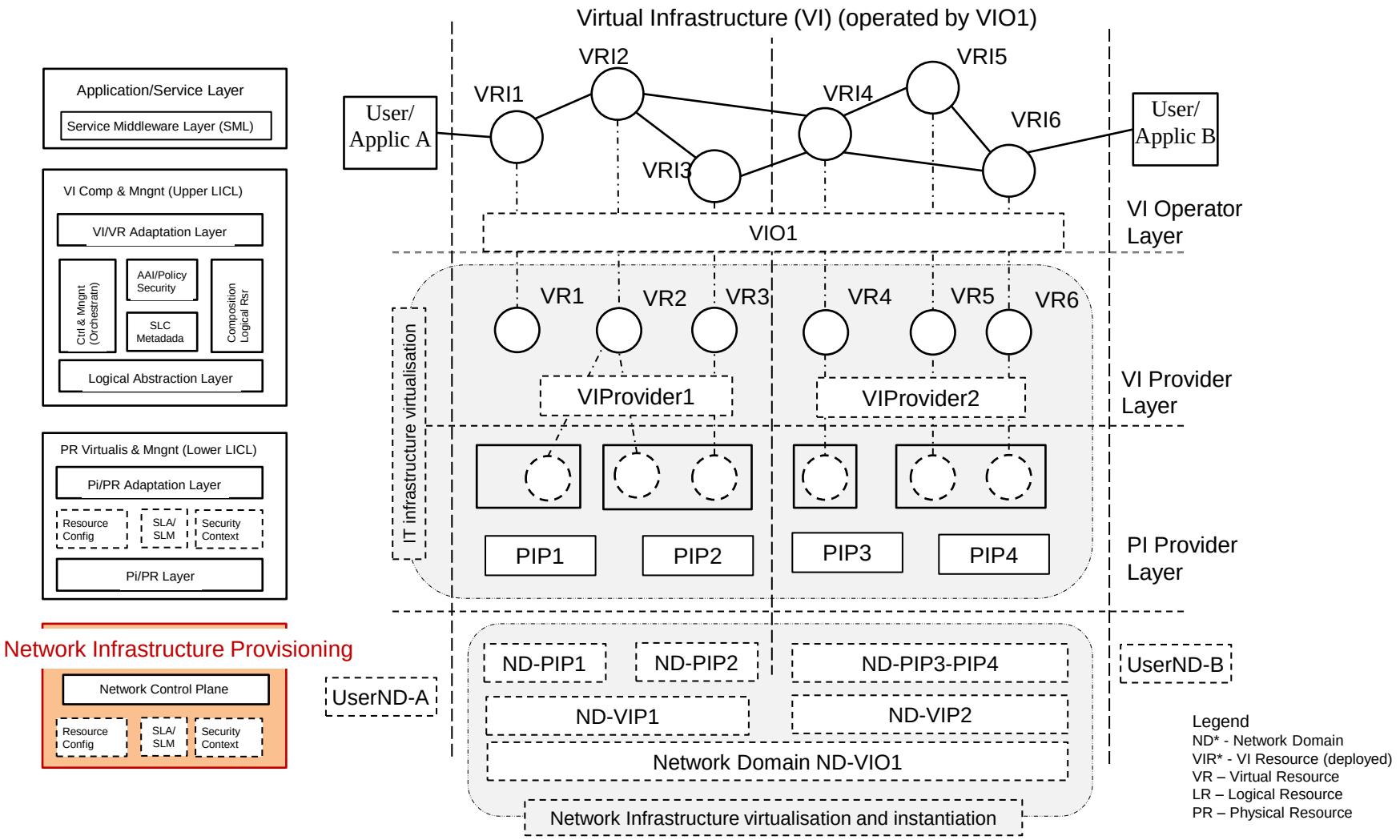
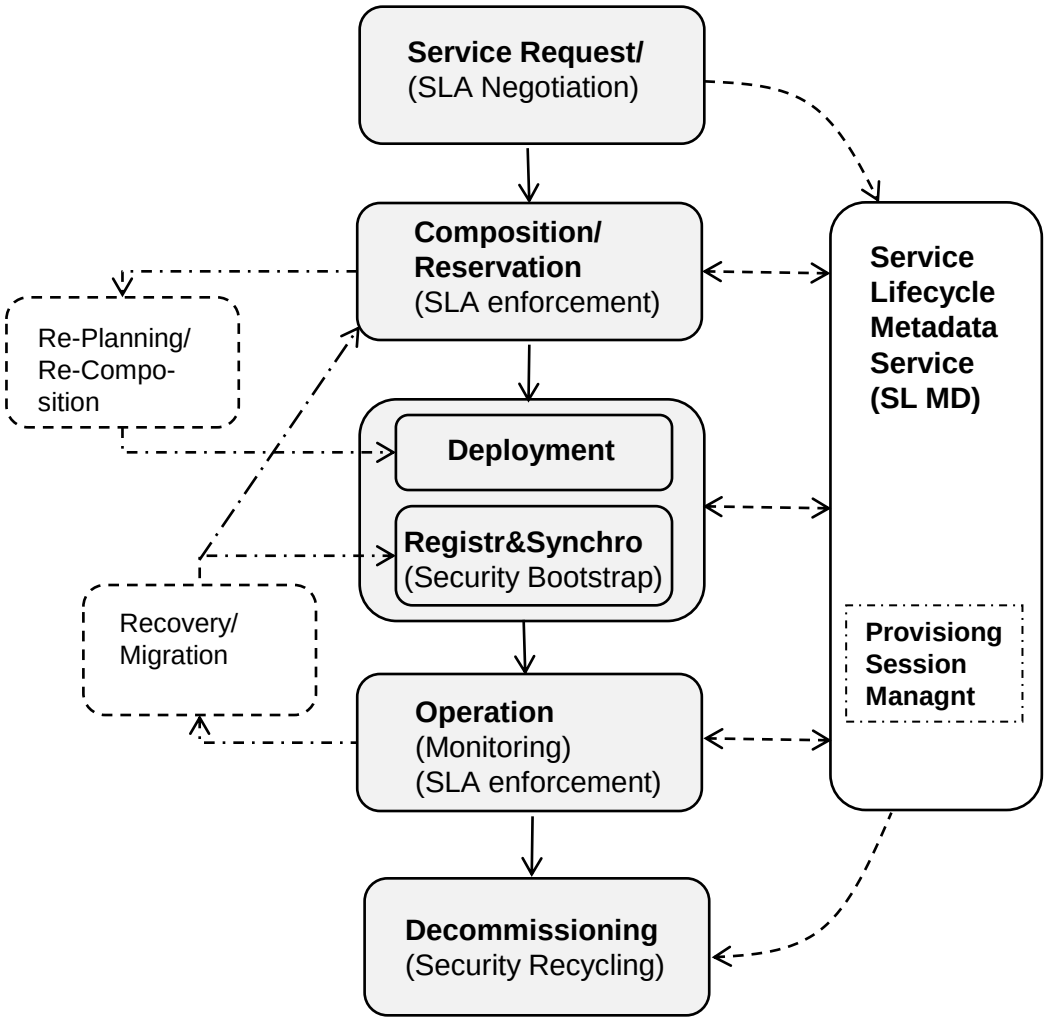


Services Lifecycle/Provisioning Workflow



- Main stages/phases
  - **Service Request** (including SLA negotiation)
  - **Composition/Reservation** (aka design)
  - **Deployment**, including Reqistration/Synchronisation
  - **Operation** (including Monitoring and SLA enforcement)
  - **Decommissioning** (including Dynamic Security Associations destroying/recycling)
- Additional stages
  - **Re-Planning**/Re-Composition should address incremental infrastructure changes
  - **Recovery/Migration** can use SL-MD to initiate resources re-synchronisation but may require re-composition
- The whole workflow is supported by the Service Lifecycle Metadata Service (SL MD)
- Provisioning session provides a framework for services context and security context management

Summary and Future works

- The proposed ICAF is based on existing standards and proposes their integration and extension
  - Includes 4 components: CSM, ICCMP, ICFF, ICOF
    - Addresses cloud services/infrastructure lifecycle management
- Future research and development primarily focused on inter-layer and inter-cloud interfaces definition
  - Re-factor GEYSERS Infrastructure virtualisation interfaces
  - Testbeds: IaaS (GEYSERS) and PaaS (GEANT3)
- Standardisation activity at IETF, OGF, TMF
  - Partnership with industry (GEYSERS partners: Telefonica R&D, Interoute, SAP, Polish Telecom, ADVA; also Cisco, Huawei)

Questions and Discussion

Yuri Demchenko – Professional Summary

- Graduated from National Technical University of Ukraine “Kiev Polytechnic Institute” (KPI) in Instrumentation and Measurement (aka Industry Automation)
- Candidate of Science (Tech) – Dissertation on System Oriented Precision Generators (1989)
- Teaching at KPI 1989-1998 – Computer Networking, Internet Technologies, Security
- Professional work in Internet technologies since 1993
  - First publications on Internet technologies and security – 1994
- Work at TERENA (Trans-European R&E Networking Association) – 1998-2002
  - Wide contacts among European and international NREN and research community
- Work at UvA with SNE group – since 2003
  - Main research areas: Cloud Computing, Big Data Infrastructures, Application and Infrastructure Security, Generic AAA&Authorisation, Grid and collaborative systems
  - EU Projects: GEYSERS, GEANT3, Phosphorus, EGEEI-II, Collaboratory.nl
  - Standardisation activity – IETF (1 I-Draft pending, 3 RFC’s published), Open Grid Forum (OGF) – ISOD-RG chairing, NIST Cloud Architecture Collaboration