

Building and Deploying Distributed Services

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GRIC Communications
http://www.gric.com





Introduction

- What are distributed services?
- Why would you want to build them?
- How could you build them?
- How did we build one?
- How could you deploy them?
- How did we deploy it?
- Where do we go from here?

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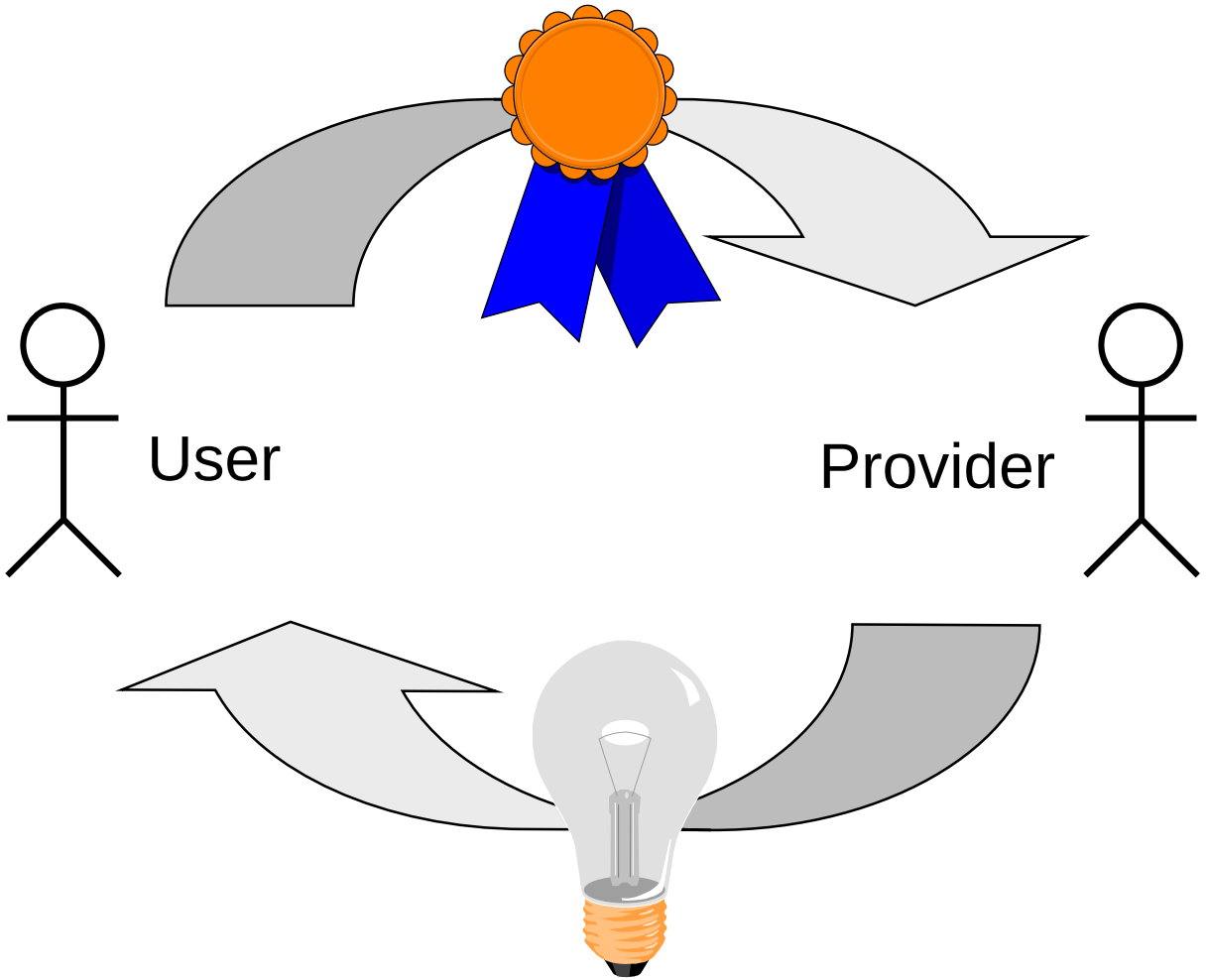
What are distributed services?



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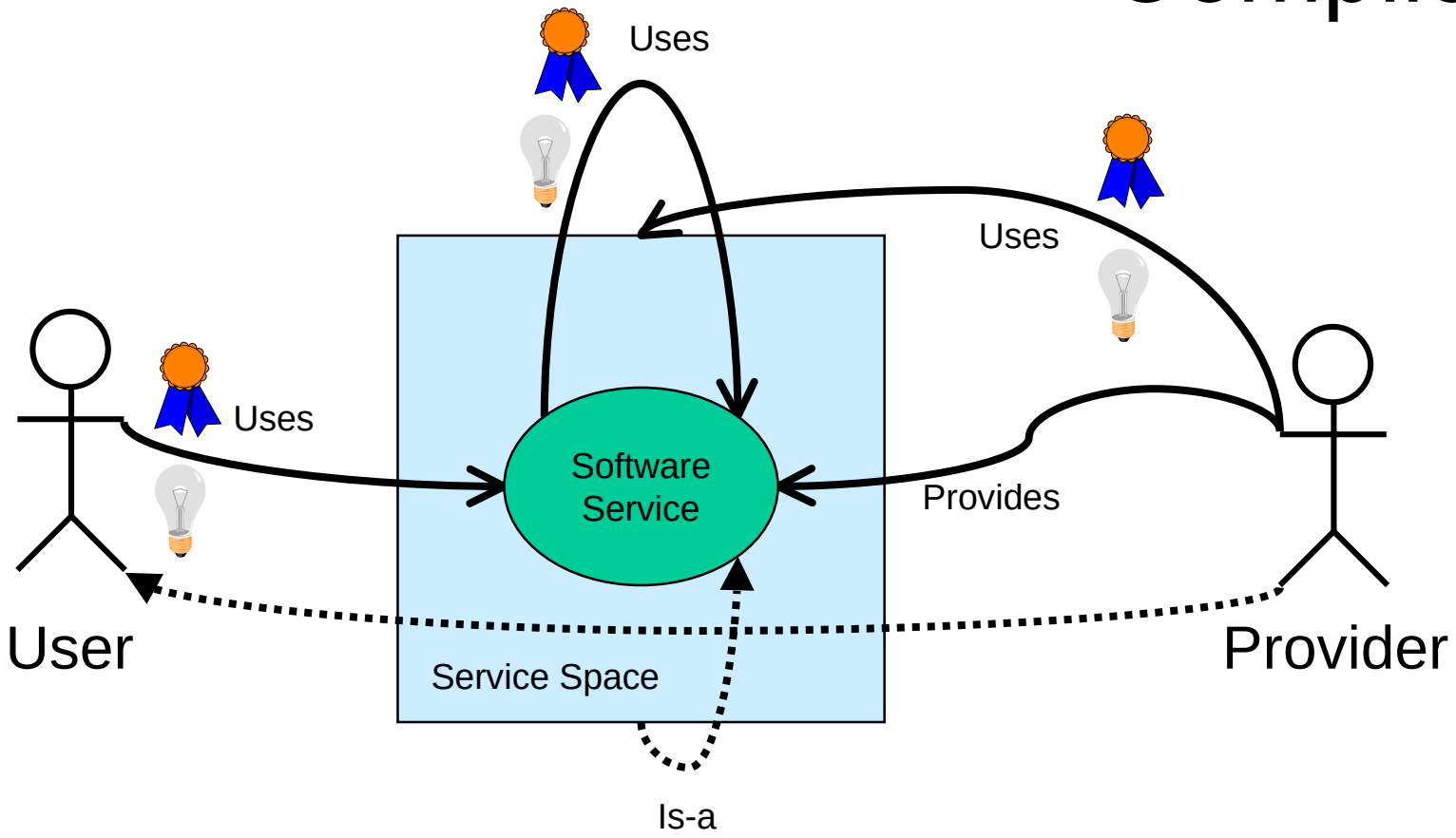


Services are Fundamental



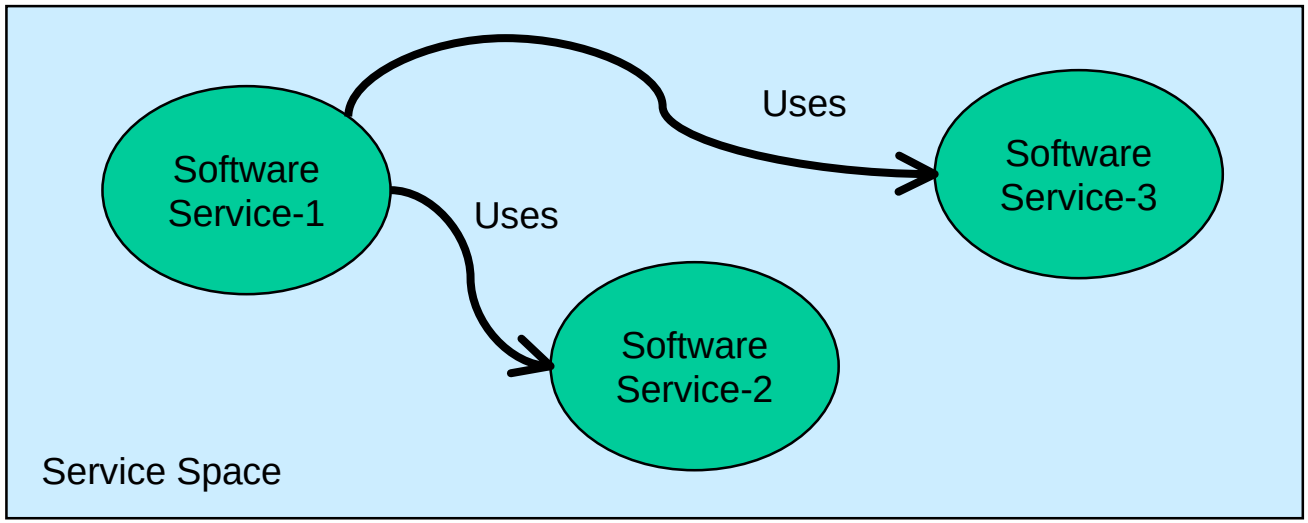
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Software Services are More Complicated



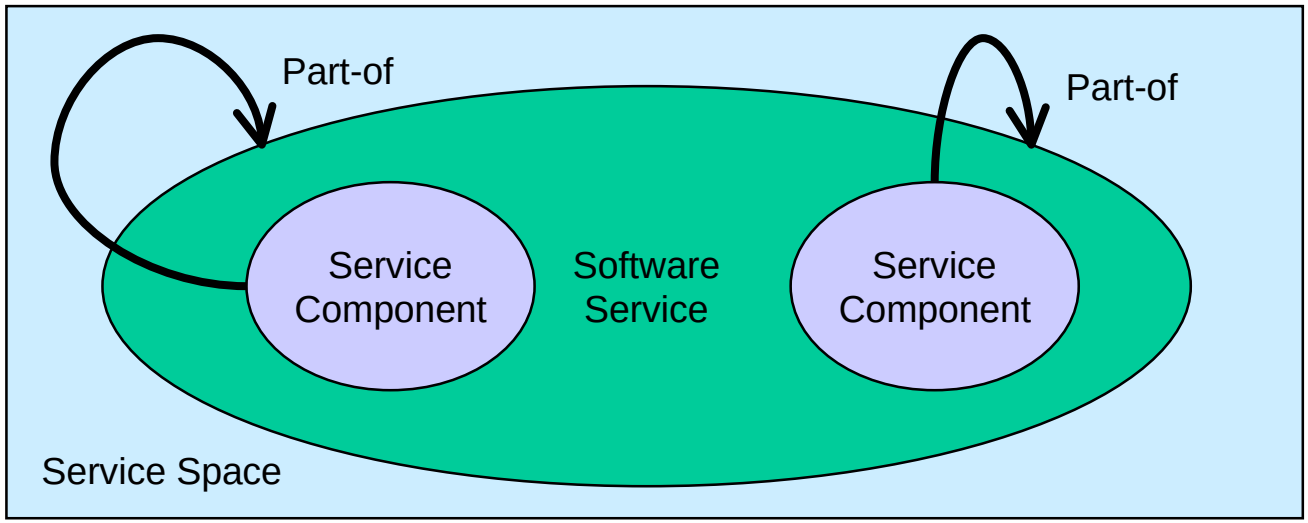
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Often They are Distributed



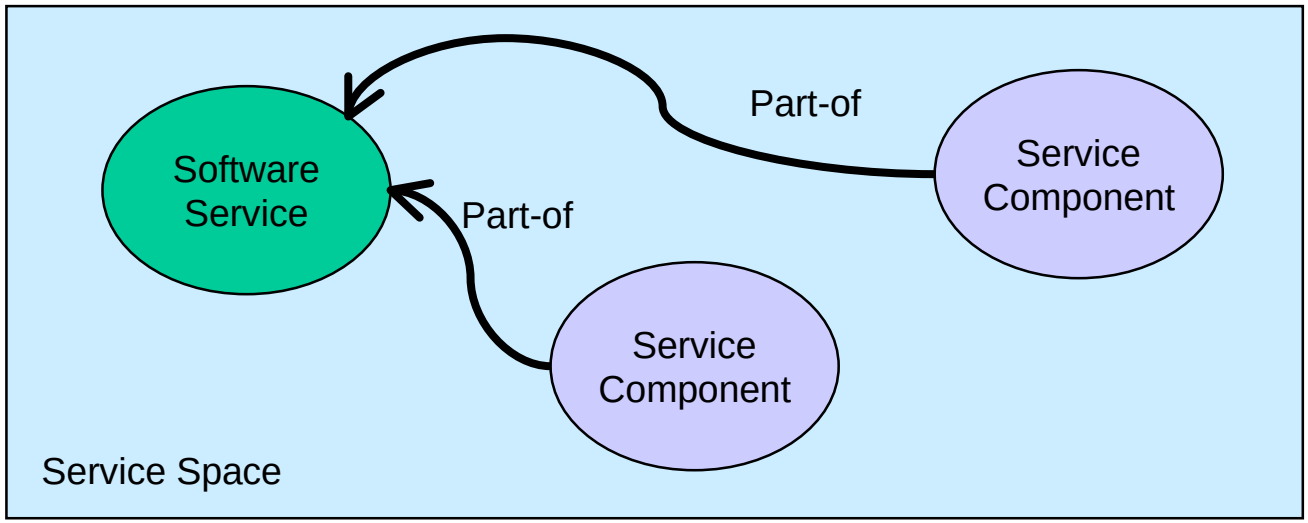
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Often They are Composed



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Sometimes Their Parts are Also Distributed



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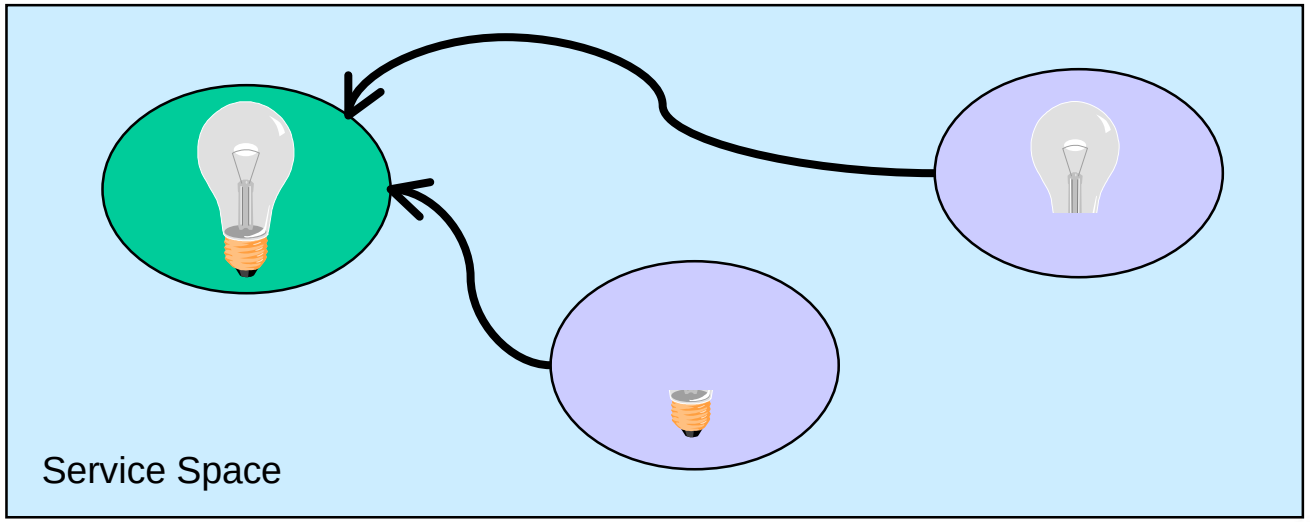
Service Design Considerations

- Organization
- Scalability
- Integrity
- Dependencies
- Introduction
- Communication

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Service Organization

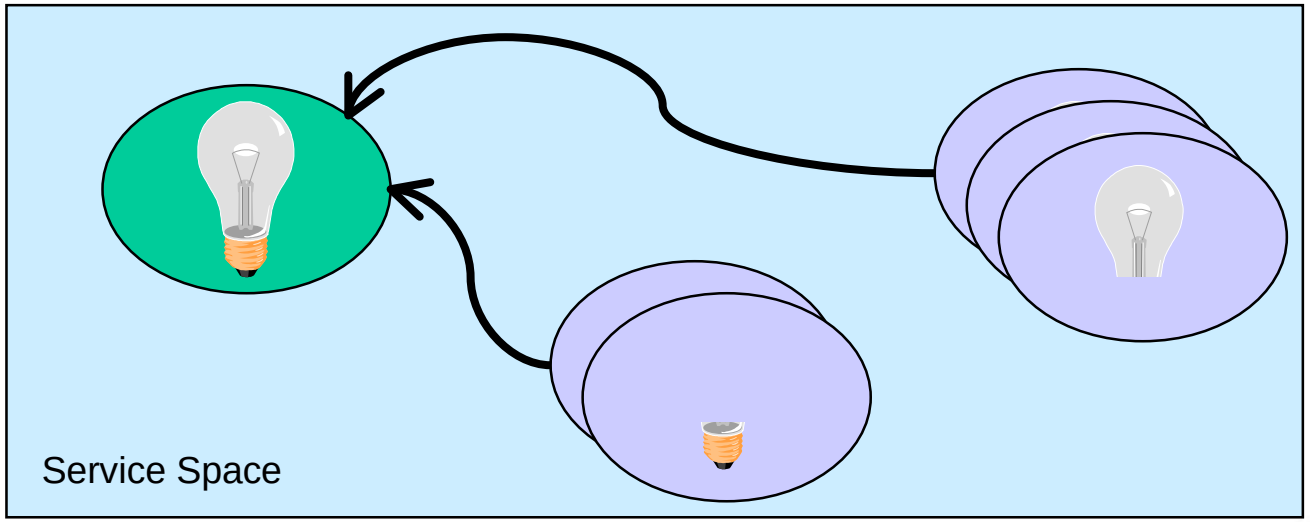
- Which portions of overall service functionality are provided by which service components?



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Service Scalability

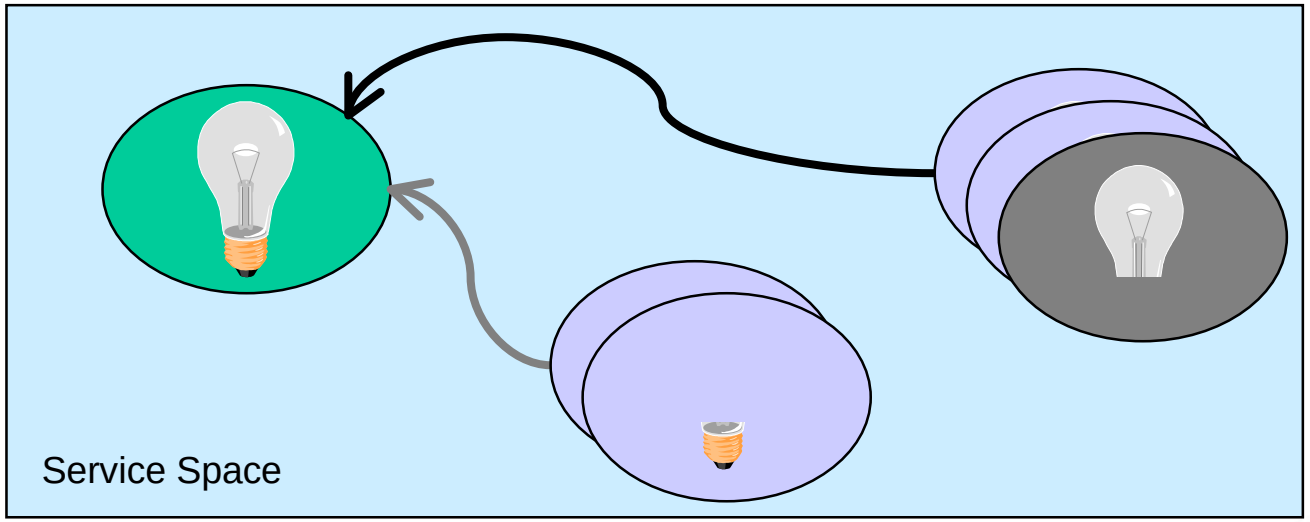
- Which service components need to be deployed in what numbers to achieve desired response times or throughput?



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Service Integrity

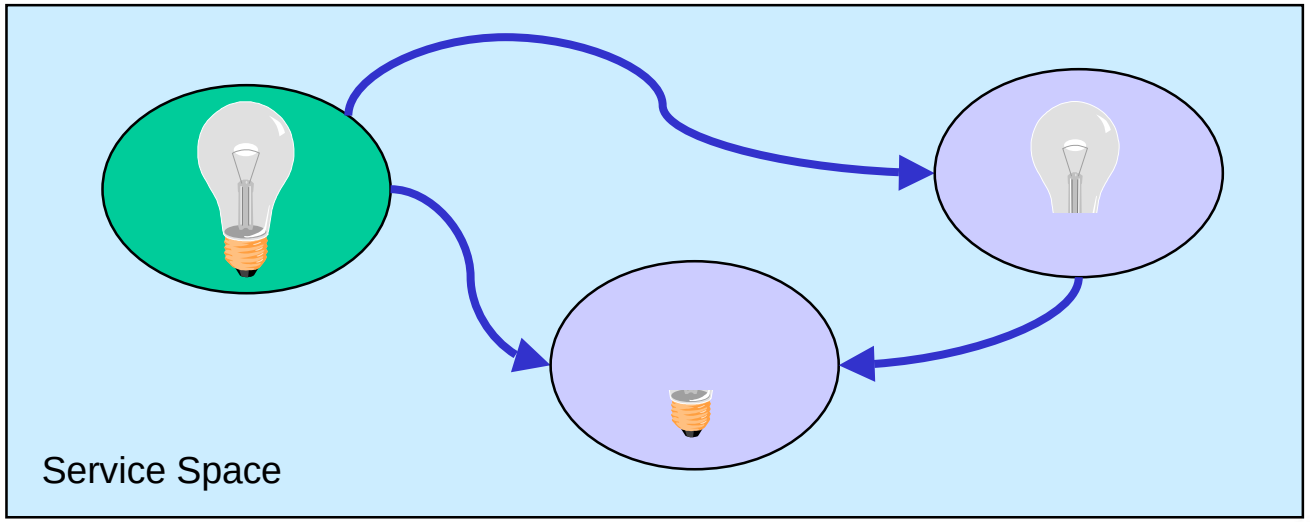
- How is overall service functionality provided in the face of network and component failures?



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Component Dependencies

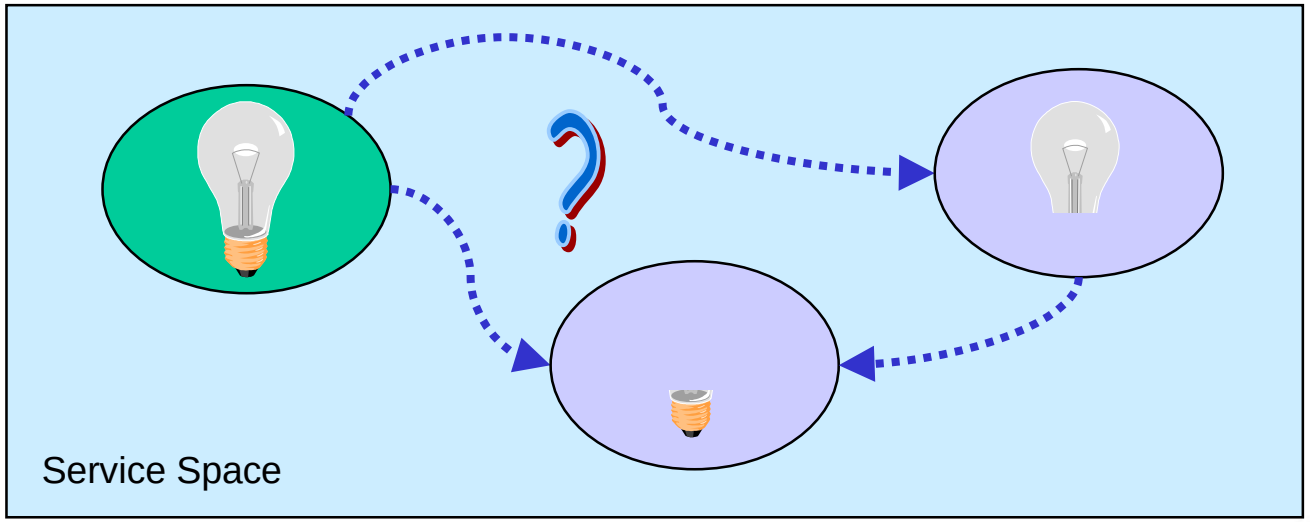
- Which service components need to communicate with each other in order to deliver overall service functionality?



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Component Introduction

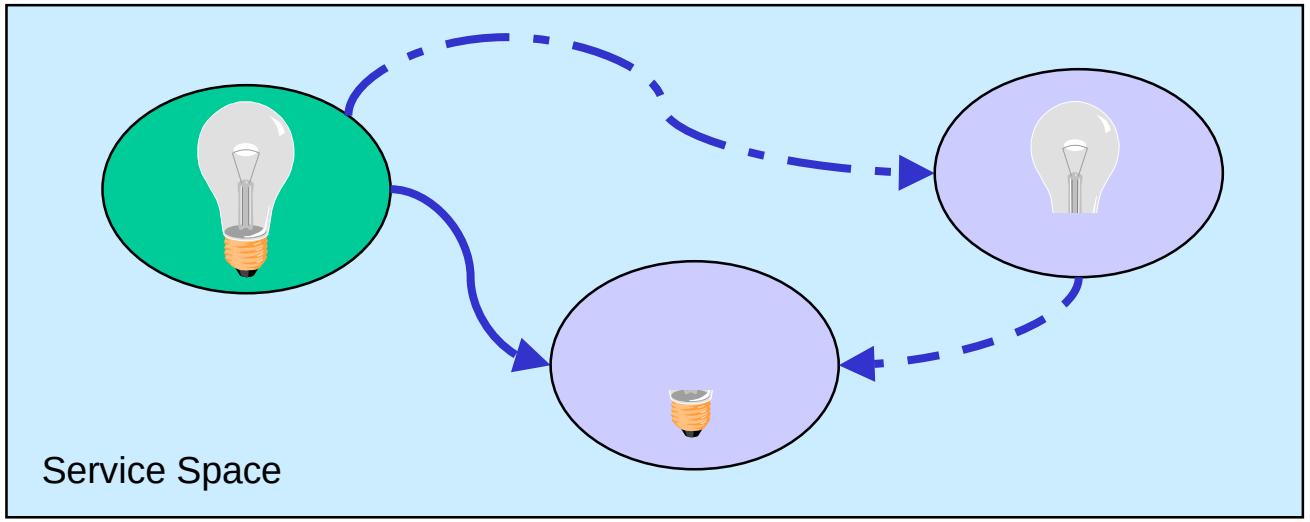
- How do service components obtain references to the other components with which they must communicate?



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Component Communication

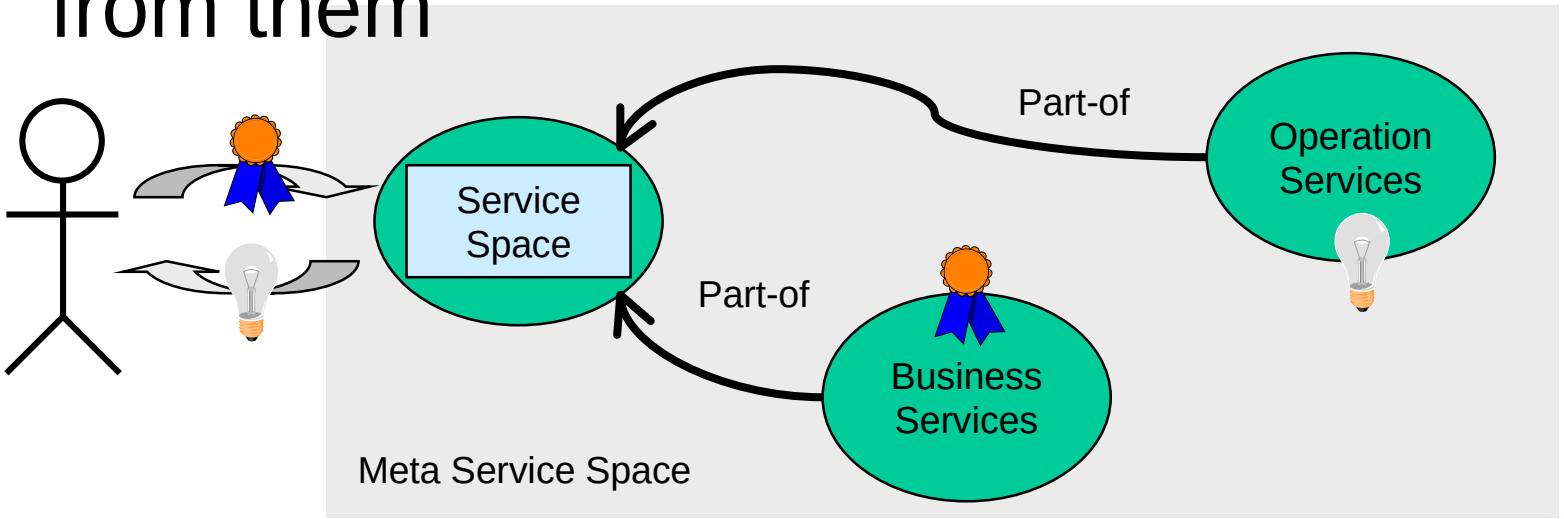
- What communication mechanisms do service components use to communicate with each other?



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Service Spaces are Services Too

- Service Spaces need to provide services for delivering other services to users and for receiving compensation from them



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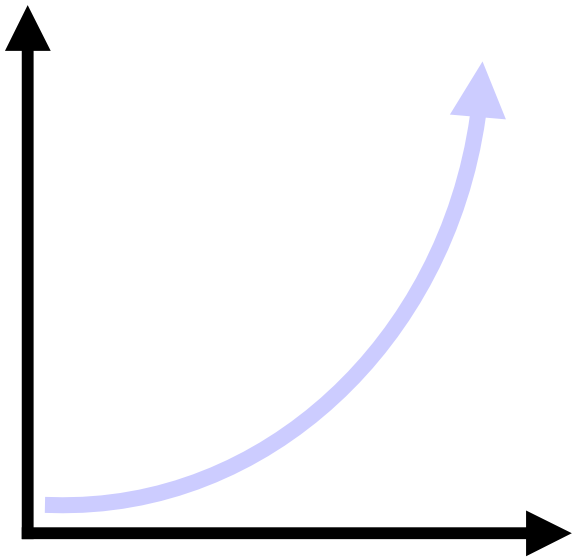
Why would you want to build them?

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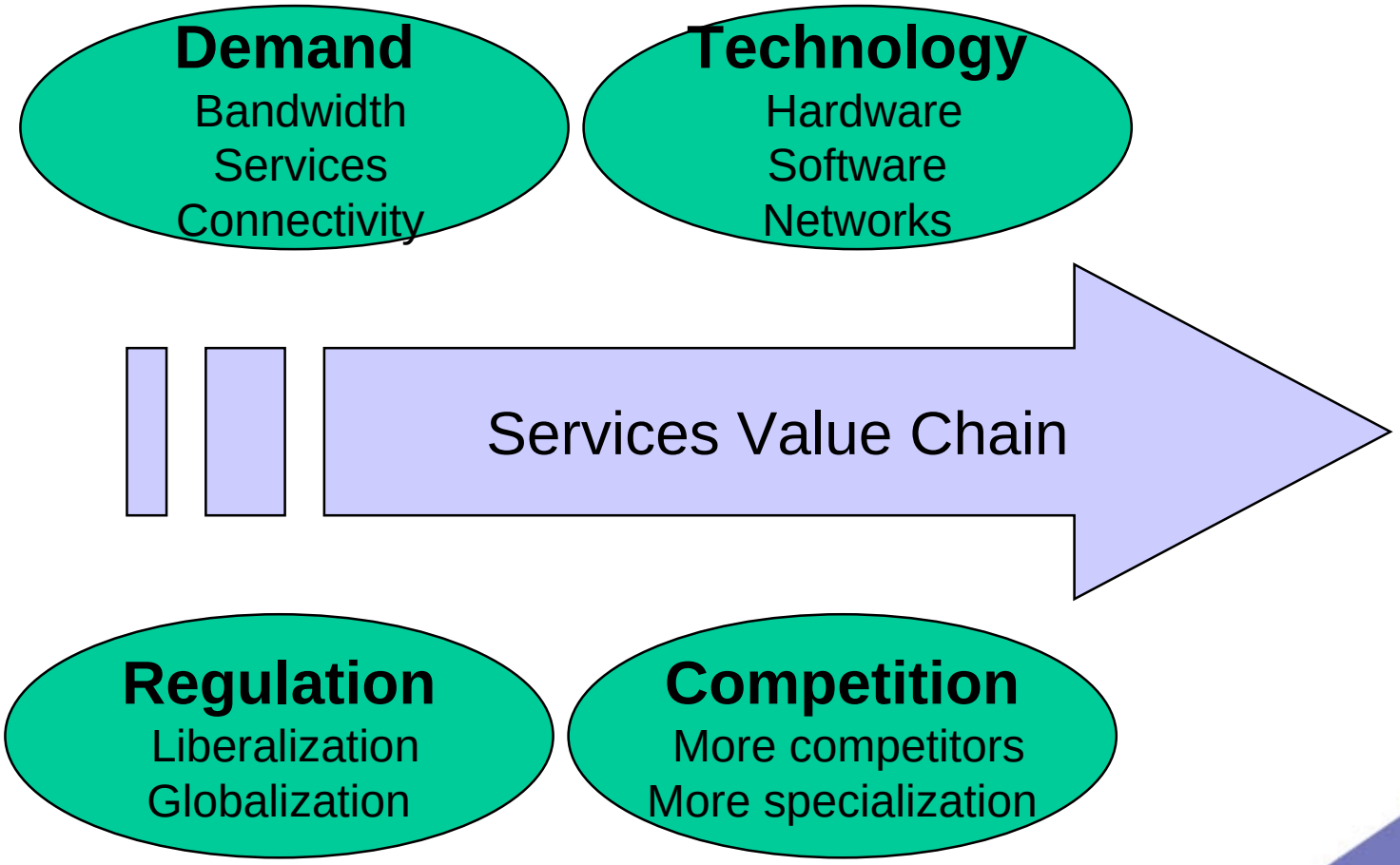
Duh, The Internet is Exploding

- *Users*
- *Connectivity*
- *Performance*
- *Services*
- *Reliability*
- *Revenue*
- *Opportunities are everywhere*



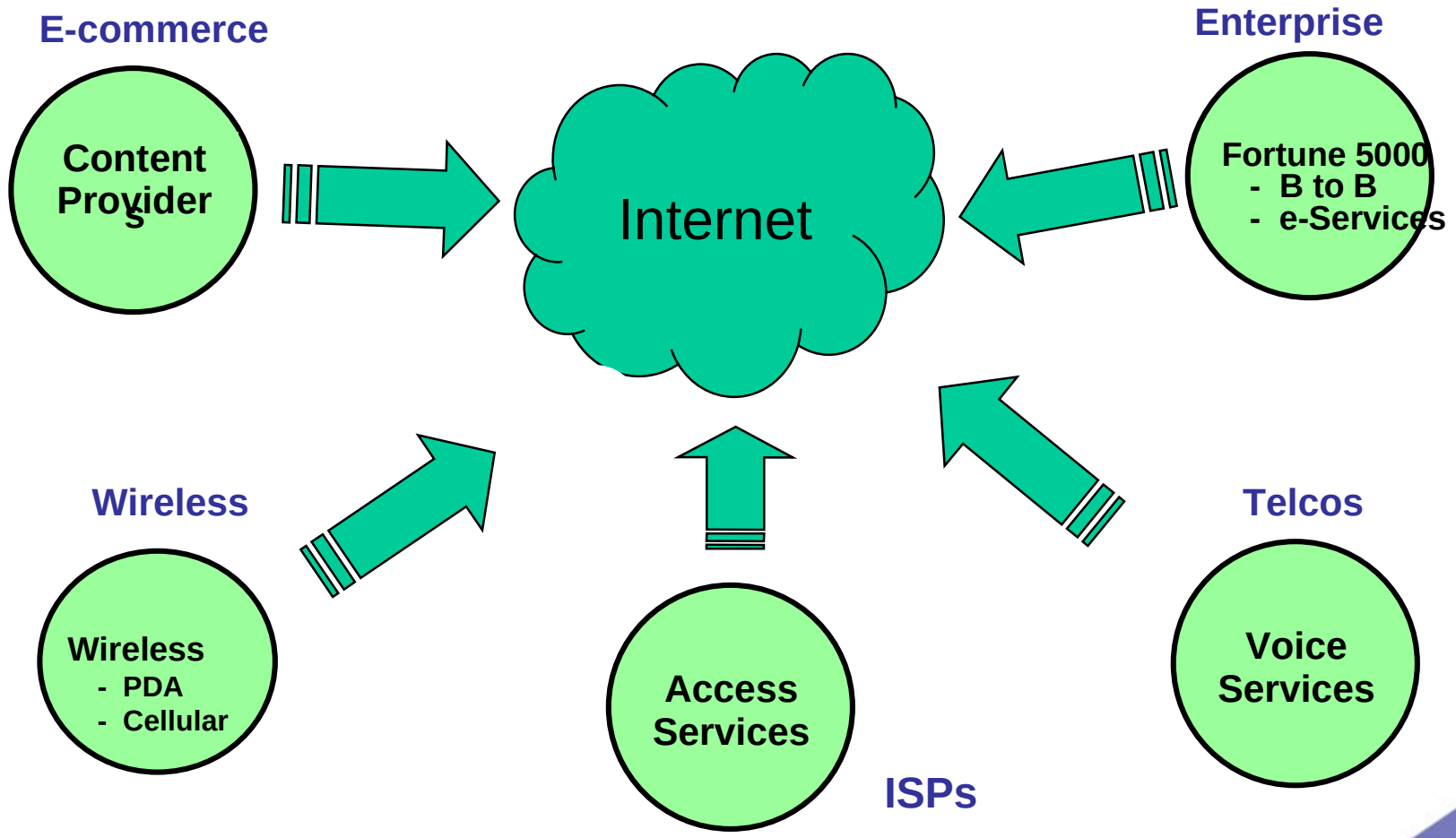
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Creative Destruction is Accelerating



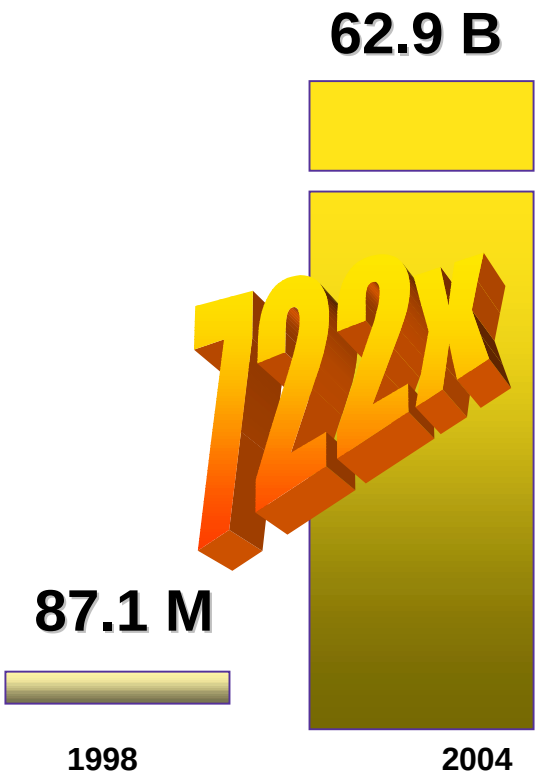
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Internet Services are Converging



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Global Internet Remote Services



Roaming Minutes

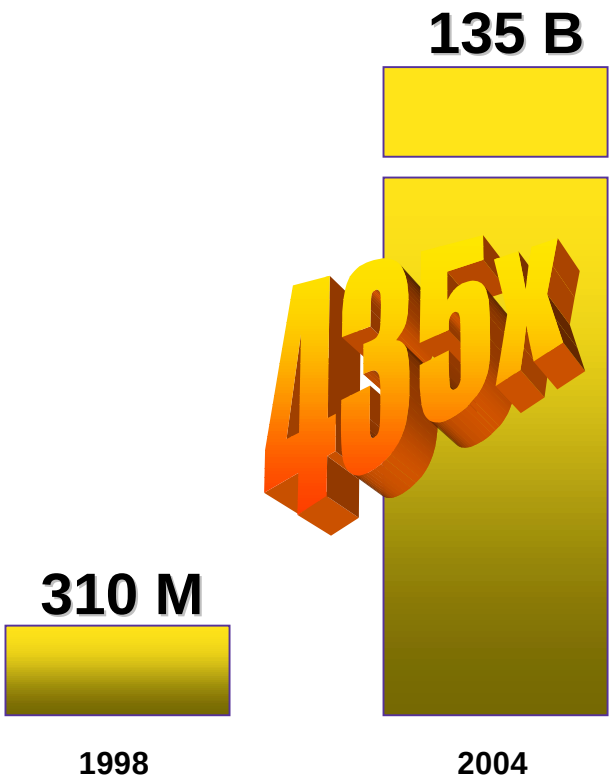


Remote Access Service Revenue

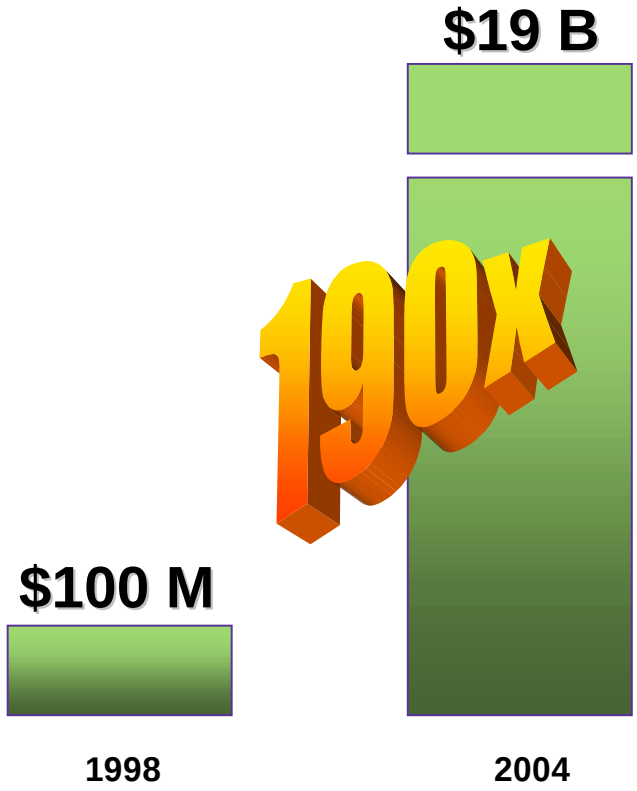
Source: Frost & Sullivan

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Internet Telephony Market



Voice Minutes

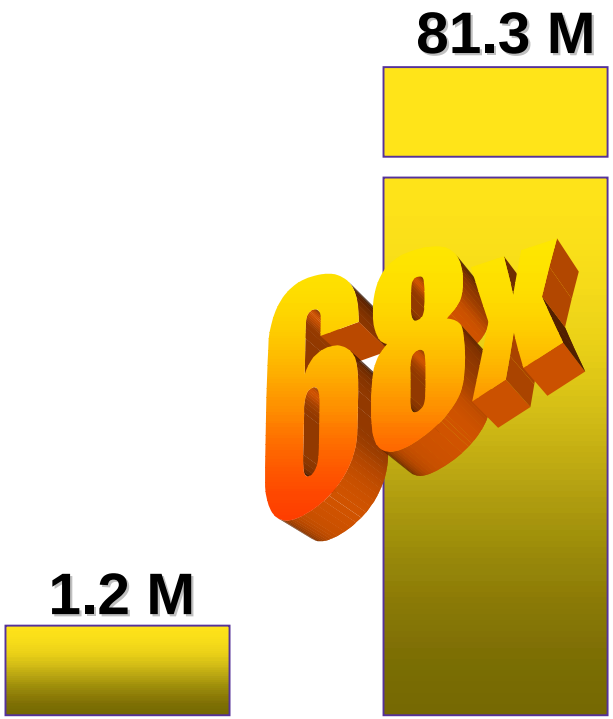


Revenue

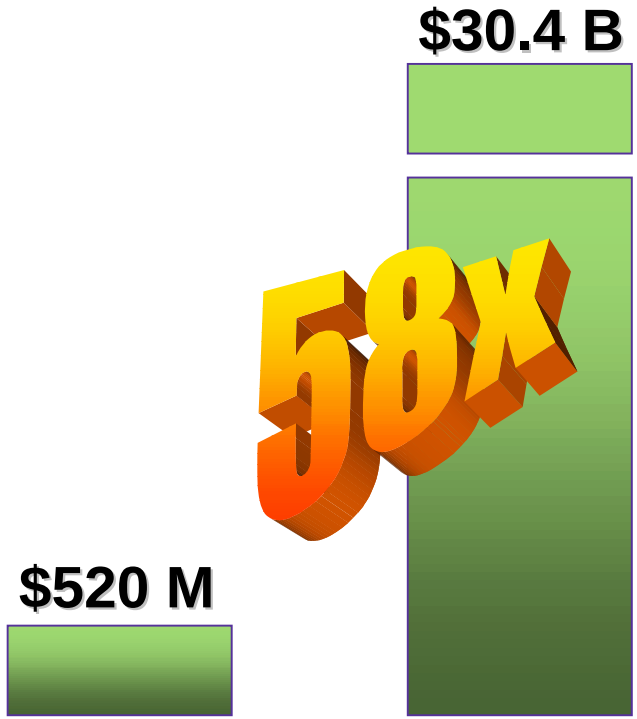
Source: IDC

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2.5G Mobile Commerce Market



Subscribers

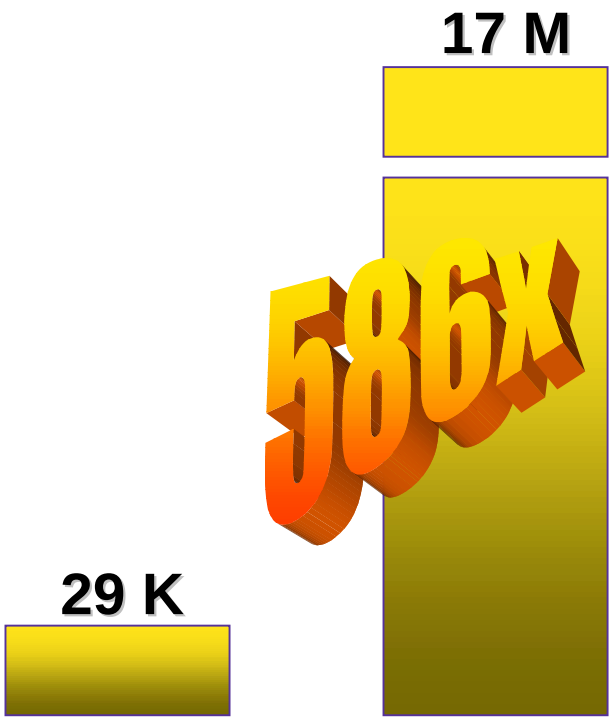


Revenue

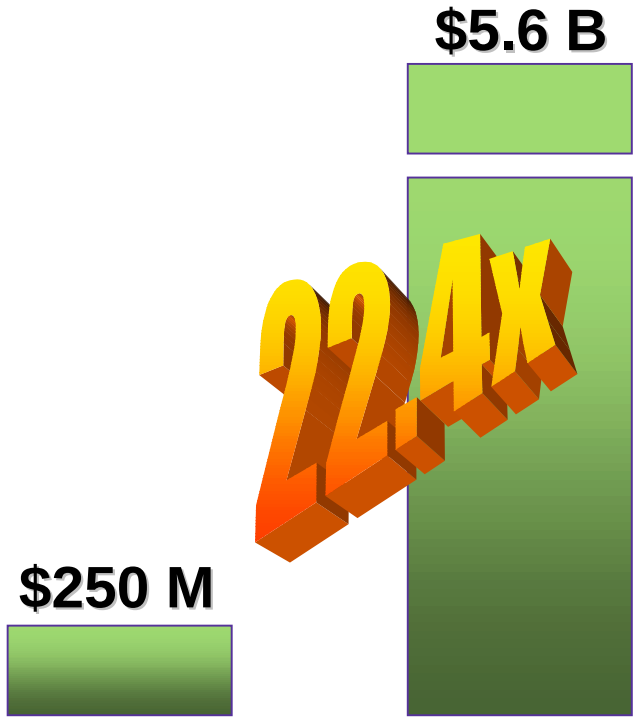
Source: Datamonitor

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3G Mobile Commerce Market



Subscribers



Revenue

Source: Datamonitor

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Technical Motivations for Building Distributed Systems

- The users are distributed
- The problem domain is distributed
- Improved scalability via load balancing
- Improved availability via replication
- Development efficiency via reuse
  - libraries & frameworks
  - domain specific languages & generators

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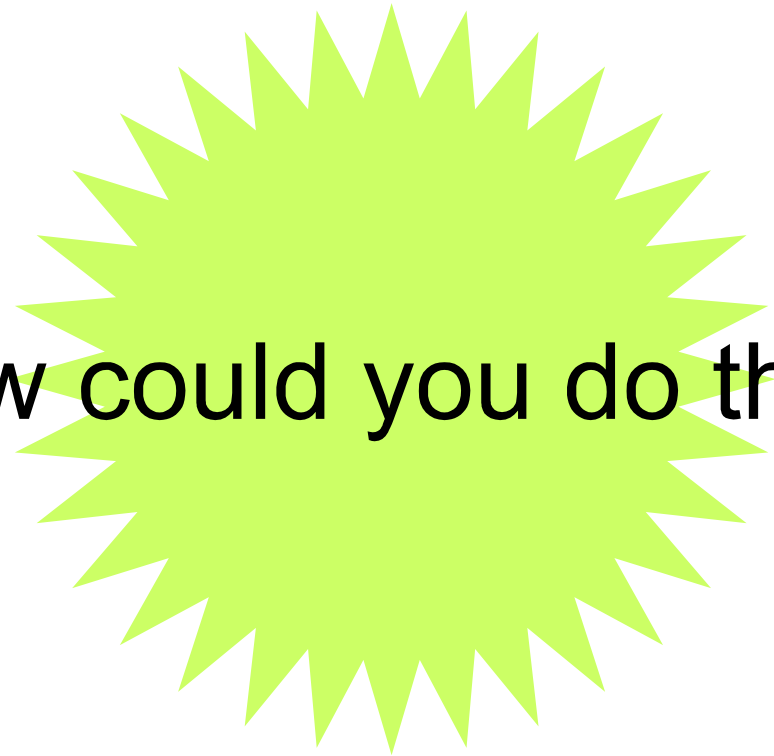


End-user Motivations for Building Distributed Services

- Distributed *Systems* are not enough per se'
- Partial failure modes require loosely coupled *Service* architectures
- Stability of relationships between services and components is not as reliable as with system elements
- Introduction and reintroduction mechanisms become key to positive user experiences

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How could you do that?

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Buy it from Microsoft? Next year?



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Assemble it from Sun? Now?

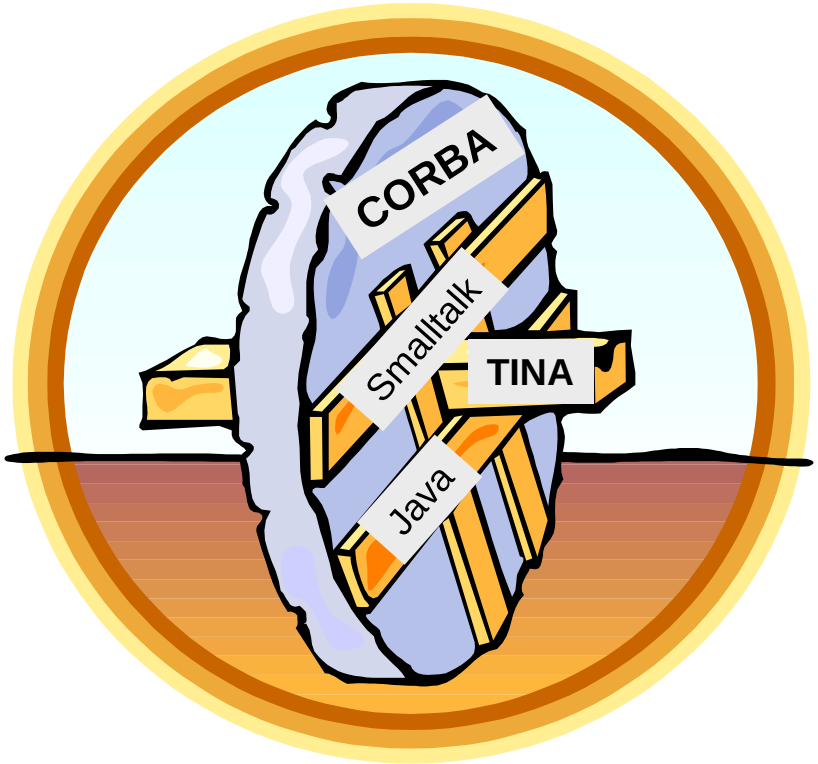
Java + Jini + Jiro+

JMX + EJB + JSP + ...

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GRIC

Build it yourself, like we did



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Technological Comparison

	.NET	Java	CORBA
• Multiple Languages	Y	N	Y
• Multiple Protocols	Y	Y	y
• Open Standards	y	y	Y
• Strong Typing	y	Y	Y
• Static Typing	n	Y	Y
• Object Oriented	y	Y	y

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Distributed Services are Inherently Complex

- Multiple, interdependent processes
- Multiple language implementations
- Multiple hardware platforms
- Multiple vendor environments
- Lots of things to go wrong ...

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Distributed Services

- A set of cooperating service components residing in different address spaces, communicating locally or over a network

Network Location \ Address Space	same	different
same	0	X
different	-	X

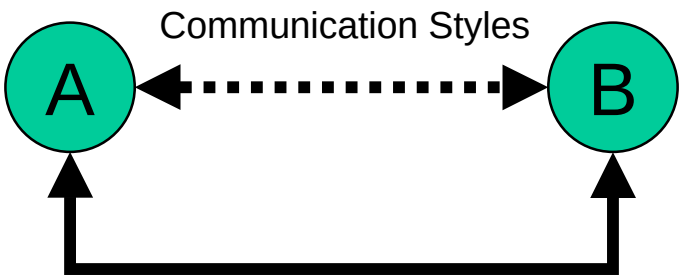
Address Space Issues
- Latency
- Type Restrictions

Network Issues
- Latency
- Type Restrictions
- Failure Modes

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Communication Styles

- The logical means whereby distributed service components communicate information between themselves



Style Issues
- Implicit vs. explicit
- Synchronous vs. asynchronous
- Push vs. Pull
- Context propagation

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Communication Protocols

- The physical means whereby distributed service components communicate information between themselves



Communication Protocols

Protocol Issues
- Network transport
- Message encoding
- Type encoding
- Value encoding
- Language binding

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Some Common Protocols

- IP
- TCP
- UDP
- HTTP

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Message-Oriented-Middleware

- IBM MQseries®
- TIBCO ActiveEnterprise®
- Vitria BusinessWare®
- CORBA Notification Service
- Java Message Service (JMS)

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Some RPC Protocols

- OSF (DCE)
- DCOM (DCE)
- Corba (IIOP, DCE)
- RMI (Java, IIOP)
- SOAP (XML)

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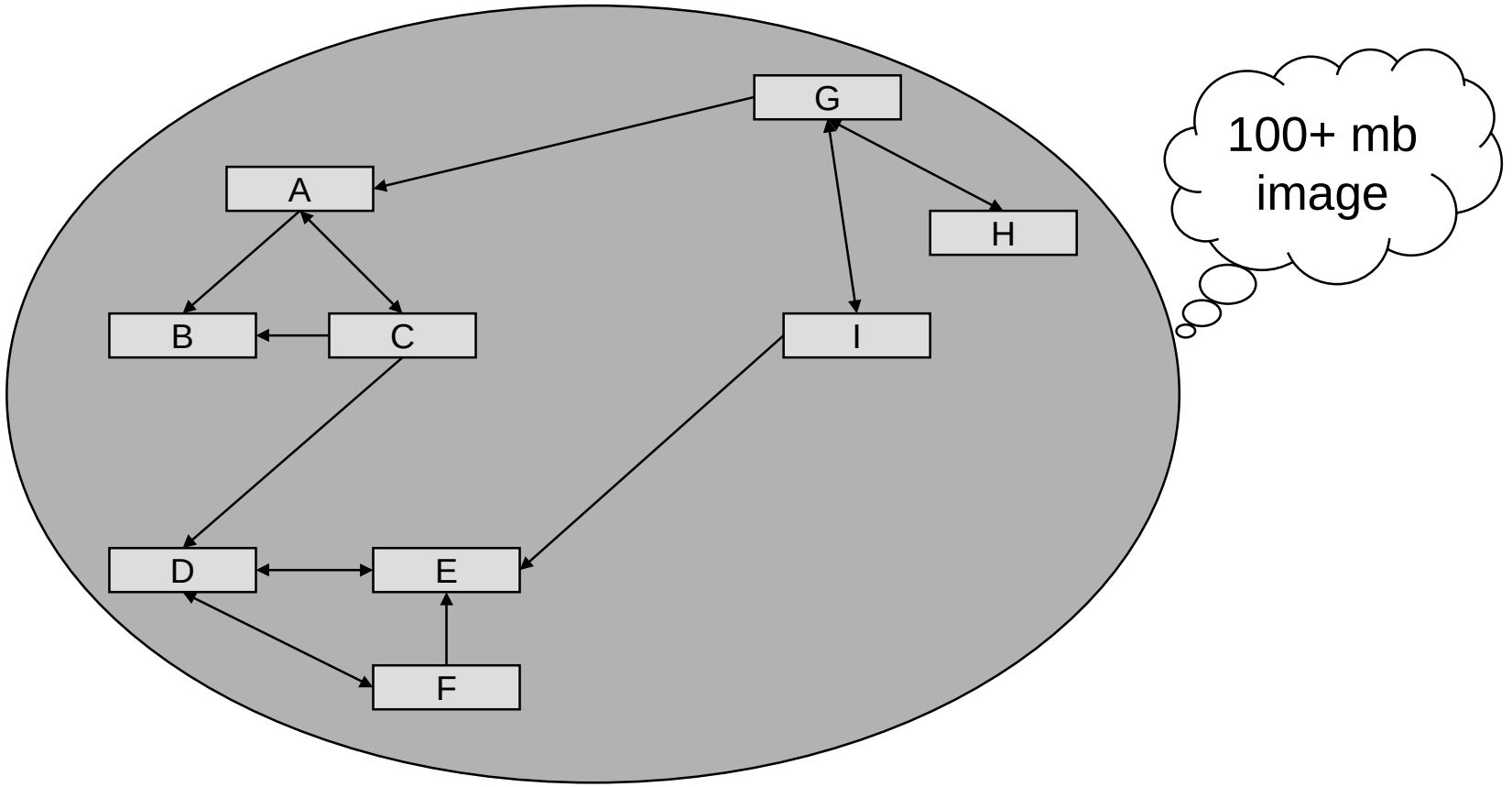
Organizing a Distributed Service

- Model domain objects' behavior, state & relationships
- Cluster related domain objects into larger granularity manager/coordinator components
  - by type and/or by instance (or both)
- Trace application *use cases* to define communication interfaces between components
- Determine component dependencies and visibility requirements

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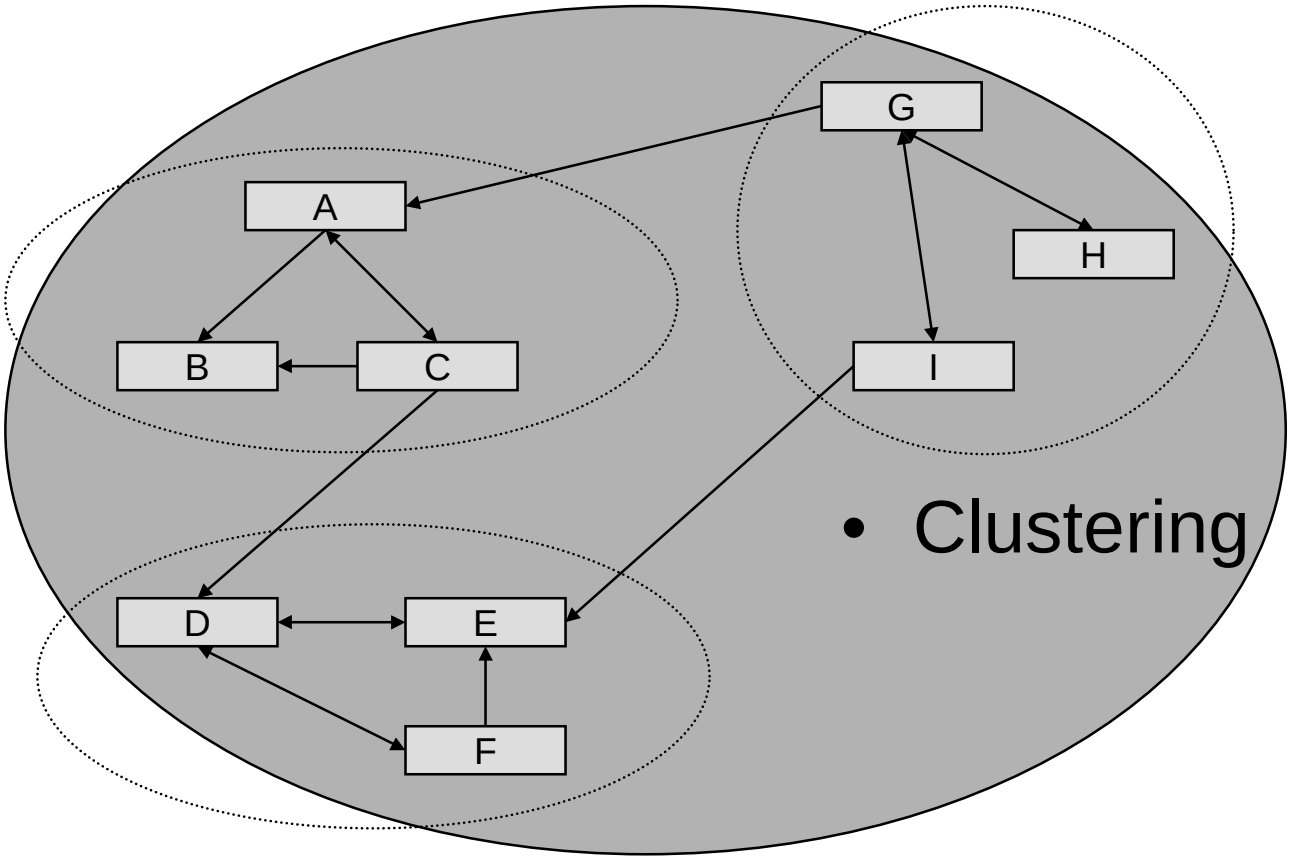


Clustering Domain Models



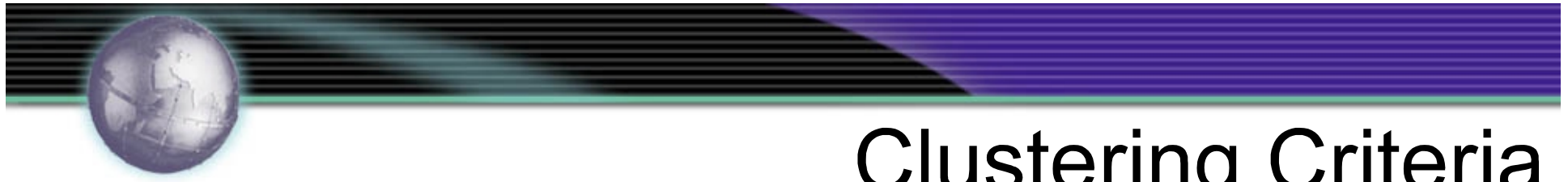
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Clustering Domain Models



- Clustering

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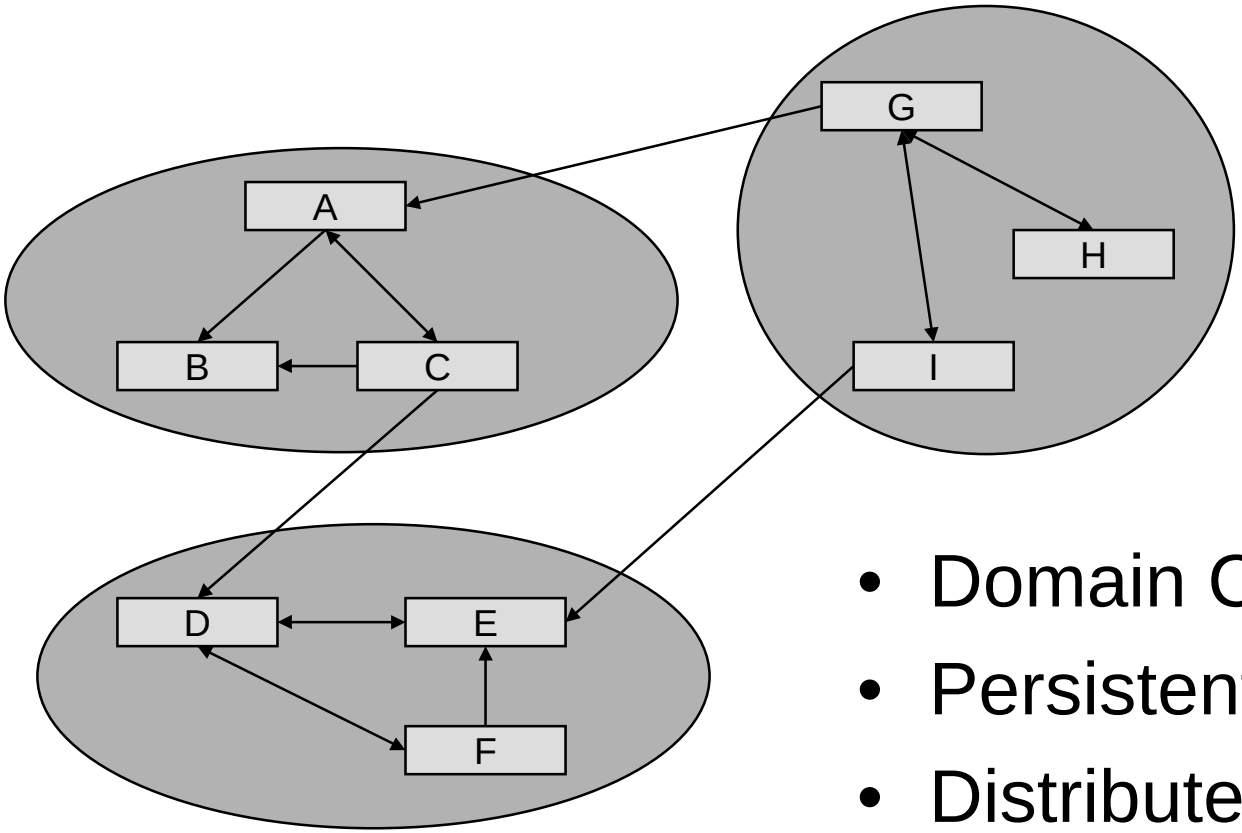
Clustering Criteria

- Locality of reference
- Locality of behavior
- Common storage requirements
- Suitable implementation languages
- Reliability and scalability goals
- Inherent organization in domain
- Administrative organization

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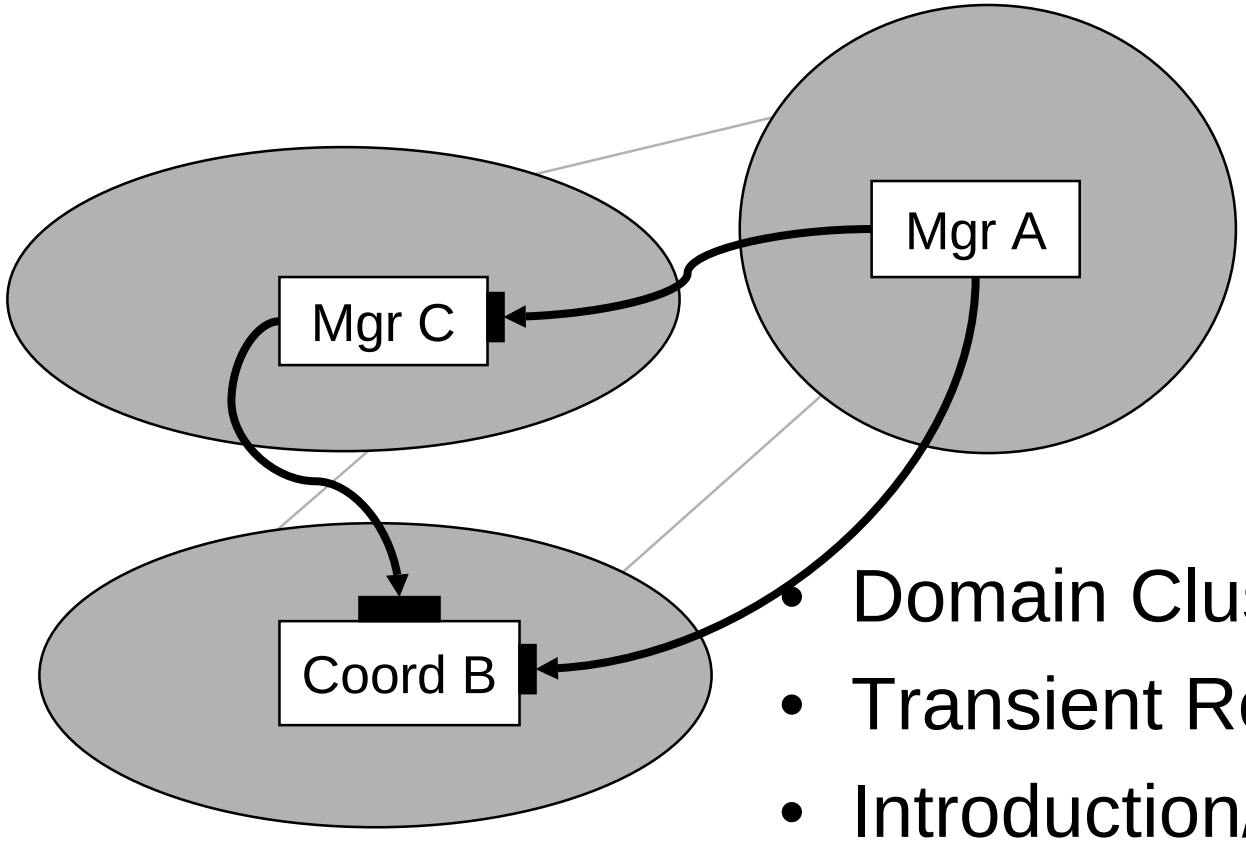
Distributing Domain Clusters



- Domain Clustering
- Persistent References
- Distributed Transactions

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Cluster Managers/Coordinators



- Domain Clustering
- Transient References
- Introduction/reintroduction
- Distributed Transactions

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Organizing the Application

- Define component objects
  - specification languages
- Determine Introduction Groups
  - manager/coordinator dependencies
  - scalability expectations
  - administrative domains
- Make Packaging Decisions
  - implementation languages
  - manager/coordinator co-location
  - failure units, redundancy

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Component Objects

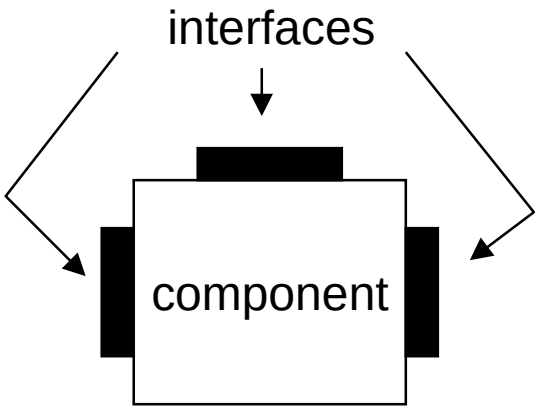
- Interfaces organize and provide component behavior to multiple potential clients
- Component objects make their interfaces selectable by name or type
- Interfaces usually not related by inheritance

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Component Object Models

- OSI ODP
- TINA
- Microsoft DCOM
- Sun EJB
- Java Jini/Jiro
- CORBA Components
- Microsoft .NET



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TINA Component Facilities

- Interfaces define behavior of components
  - trading attribute declarations
- Objects support multiple interfaces
  - ODL a superset of CORBA IDL definition
  - define required, supported interfaces
  - define source, sink of typed media streams
- Groups cluster Objects and sub-Groups
  - trading for object introduction
  - contracts control interface visibility

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Enterprise Java Beans

- Interfaces define behavior of “Enterprise Beans”
  - standard Java definition
  - session, entity beans
- Beans support multiple interfaces
  - inheritance & composition
  - events added in EJB 2.0
  - home interface for lifecycle & lookup

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Enterprise Java Beans

- Containers provide standard environment
  - Lifecycle
  - State
  - Transactions
  - Security
  - Persistence

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CORBA Components

- “Language independent EJB, TINA fusion”
- Interfaces define behavior of components
- Components support multiple interfaces
  - persistent or transient session, entity components
  - CDL superset of CORBA IDL definition
  - define required, supported interfaces
  - define generated, received events
  - home interfaces for lifecycle & lookup

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CORBA Components

- Containers provide common services
  - Persistence
  - Transactions
  - Naming
  - Communication
  - Security
- Components packaged for container insertion using XML data structures
- Still a work in progress...

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Jini Component Facilities

- "Compatible" with EJB
  - low level, smart device design target
- Trading based introduction mechanism
  - UDP protocol for discovering registries
  - RMI protocol for service registration
  - RMI protocol for service lookup
- "Central administration doesn't scale"
- "Evolution must be chaotic" Jim Waldo, Sun

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.NET Service Facilities

- Web evolving to 3rd generation services
  - service to service interactions
- Services are self describing
  - language independent
  - XML based WSDL, SOAP
- Services are discovered dynamically
  - DISCO, active metadata
- LOTS of new information to digest...

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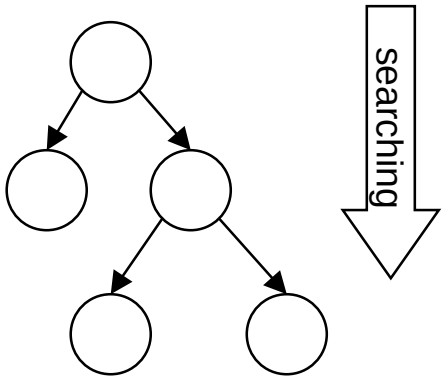
Service/component introduction

- Direct
  - Reference (e.g. business cards)
    - “you know something you want”
- Indirect
  - Naming (e.g. white pages)
    - “you know a name for what you want”
  - Trading (e.g. yellow pages)
    - “you can describe what you want”

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Introduction Strategies

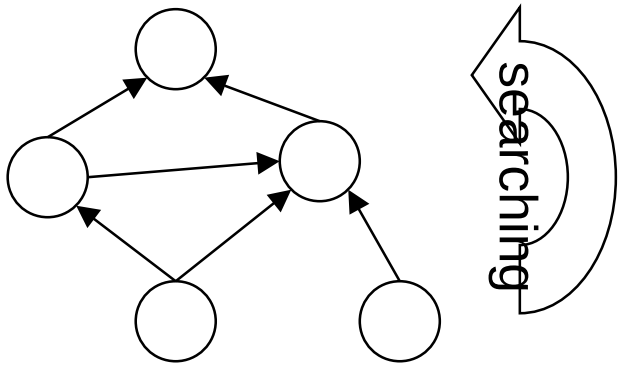
- Naming Services
  - hierarchical graph (usually)
  - objects organized by name
  - lookup uses path expressions
  - examples
    - x.500
    - CORBA Naming
    - Microsoft Active Directory
    - Sun JNDI



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Introduction Strategies

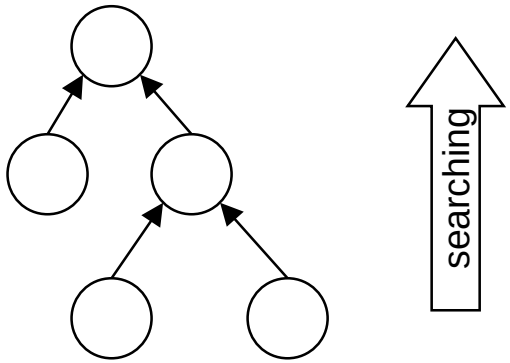
- Trading Services
  - network graph
  - objects organized by type, attributes
  - federated lookup using predicate expressions
  - examples
    - OSI Trading
    - TINA Groups
    - CORBA Trading
    - Java Jini



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TINA Groups

- Contain multiple objects and subgroups
- Index interfaces by type & attributes
- Search expressions and selection criteria
- *Contracts* control interface export to parent
- Searches upward bounded by hierarchy root



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Service Description Languages

- TINA ODL
  - CORBA IDL superset w/ trading attributes, objects, groups, streams
- CORBA CDL
  - CORBA IDL superset w/ facets, events, components
- .NET WSDL
  - web-centric services a loose collection of ports (interfaces) with operations

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How did we build one?

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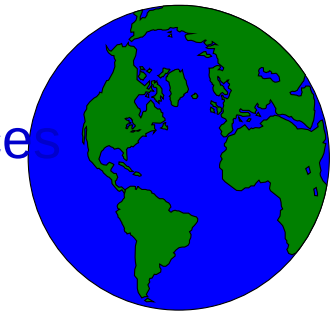
The IP Service Network Opportunity

Service Providers Have

Regional networks

Limited IP-based services

Independent billing systems



End-Users Want

Seamless global access

Multiple IP-based services

Single bill

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What IP Service Providers Need

Global reach

New services

New sources of revenue

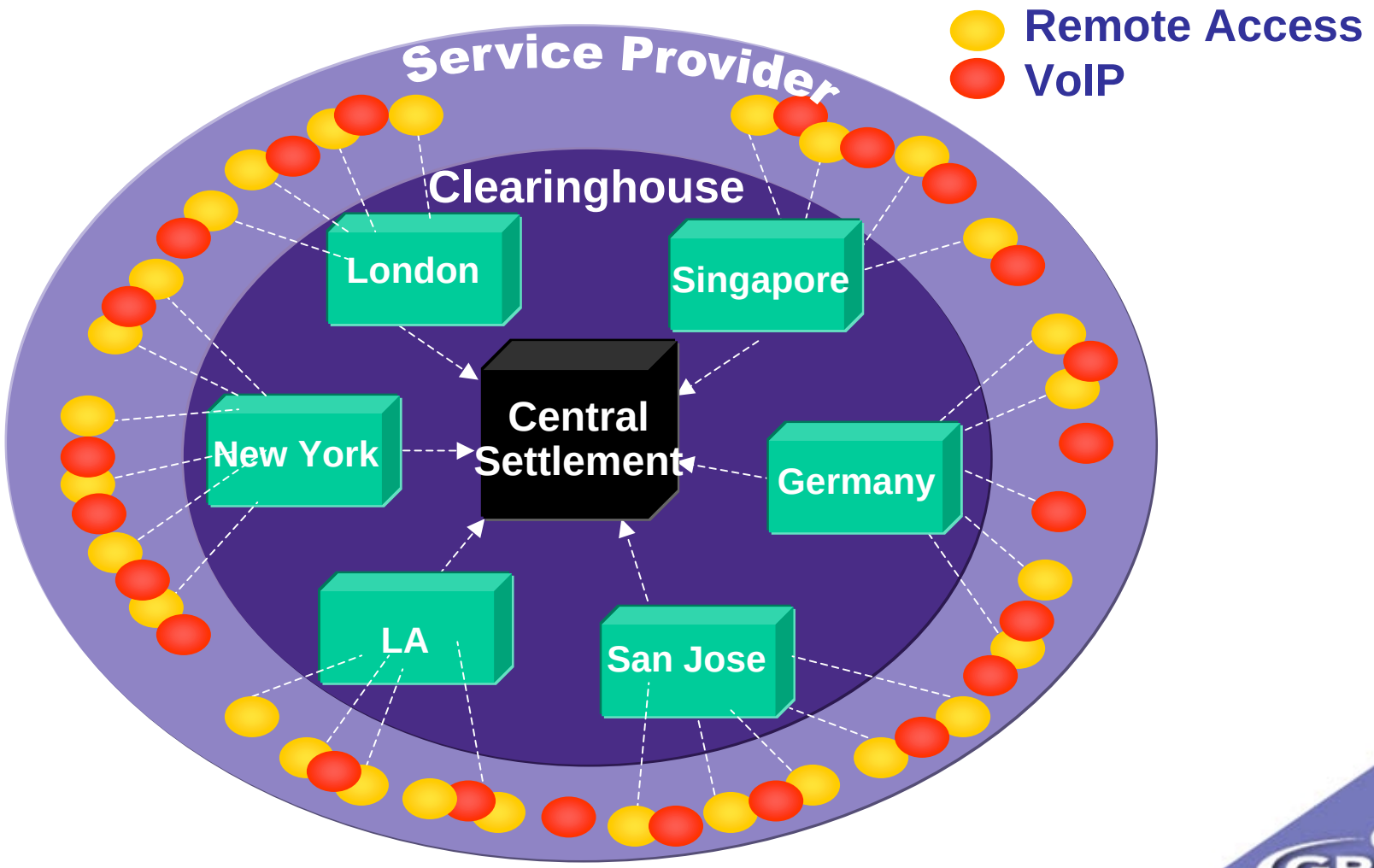
Lower costs

Growing customer base

An independently managed platform of common technology, service and payment standards

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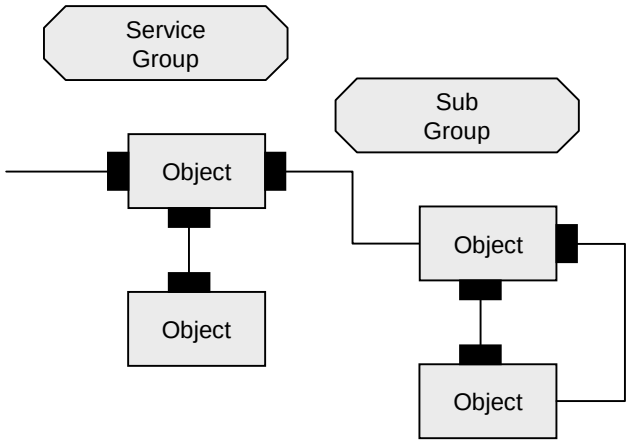
Global Service Provisioning



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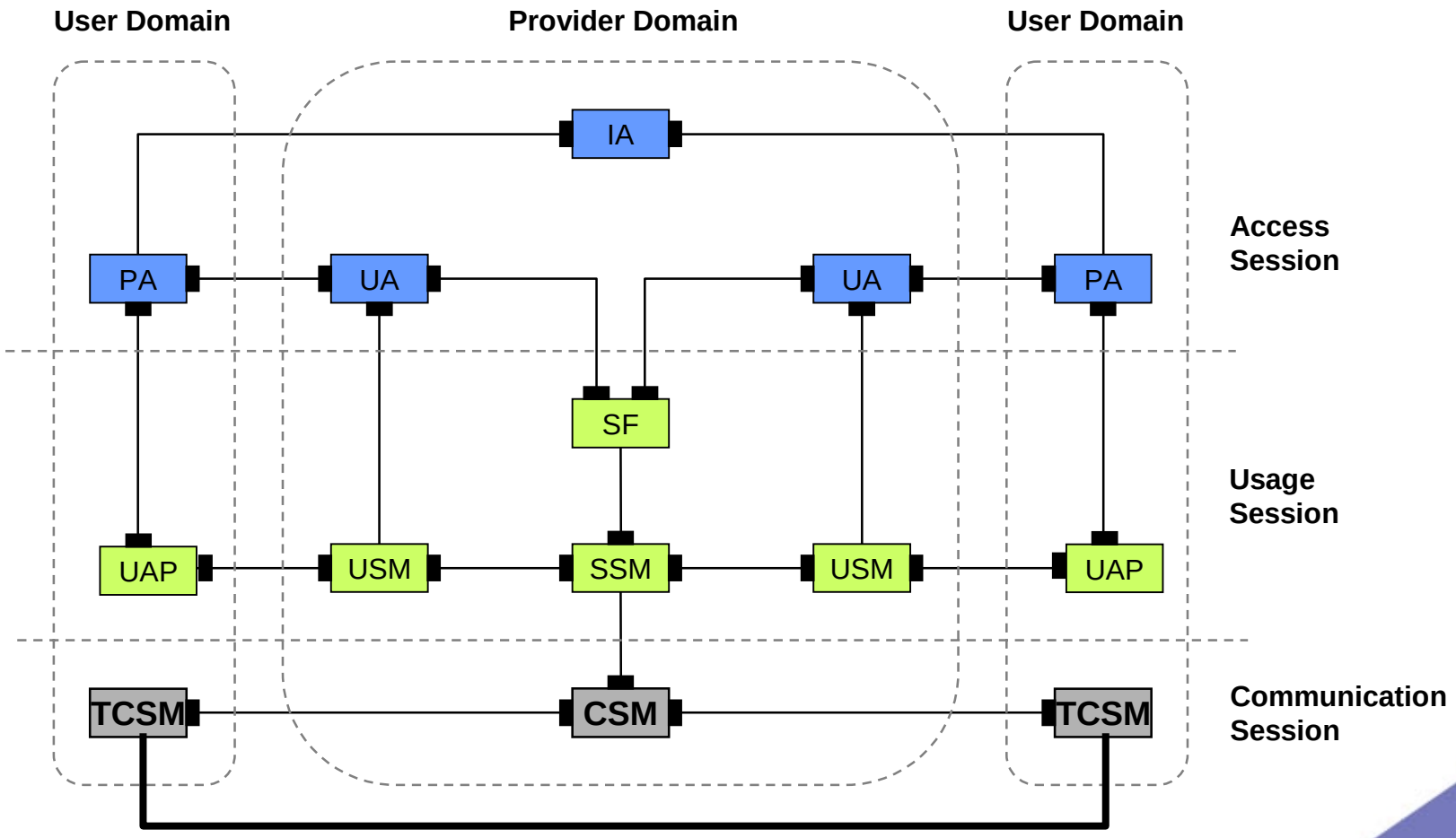
TINA Component Object Model

- Logical definition
  - *groups*
  - *objects*
  - *interfaces*
- Groups provide
  - trading to introduce objects
  - component object lifecycle



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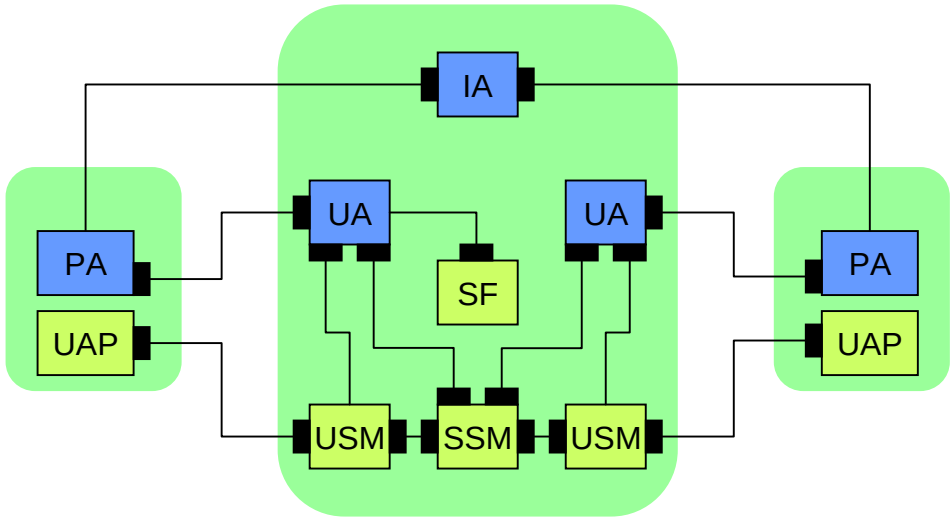
TINA Service Architecture



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Access Service

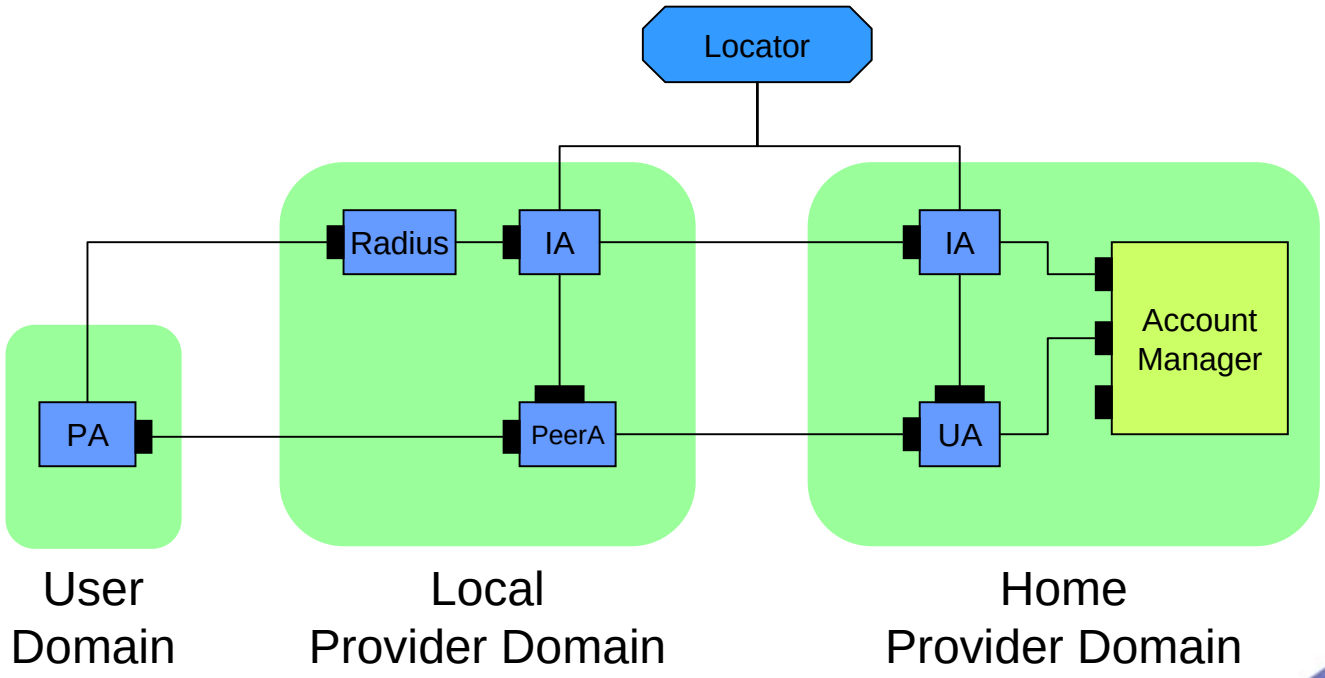
- Begin Access
- Begin Usage
- Invite User
- Join Service
- End Usage
- End Access



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Roaming Access

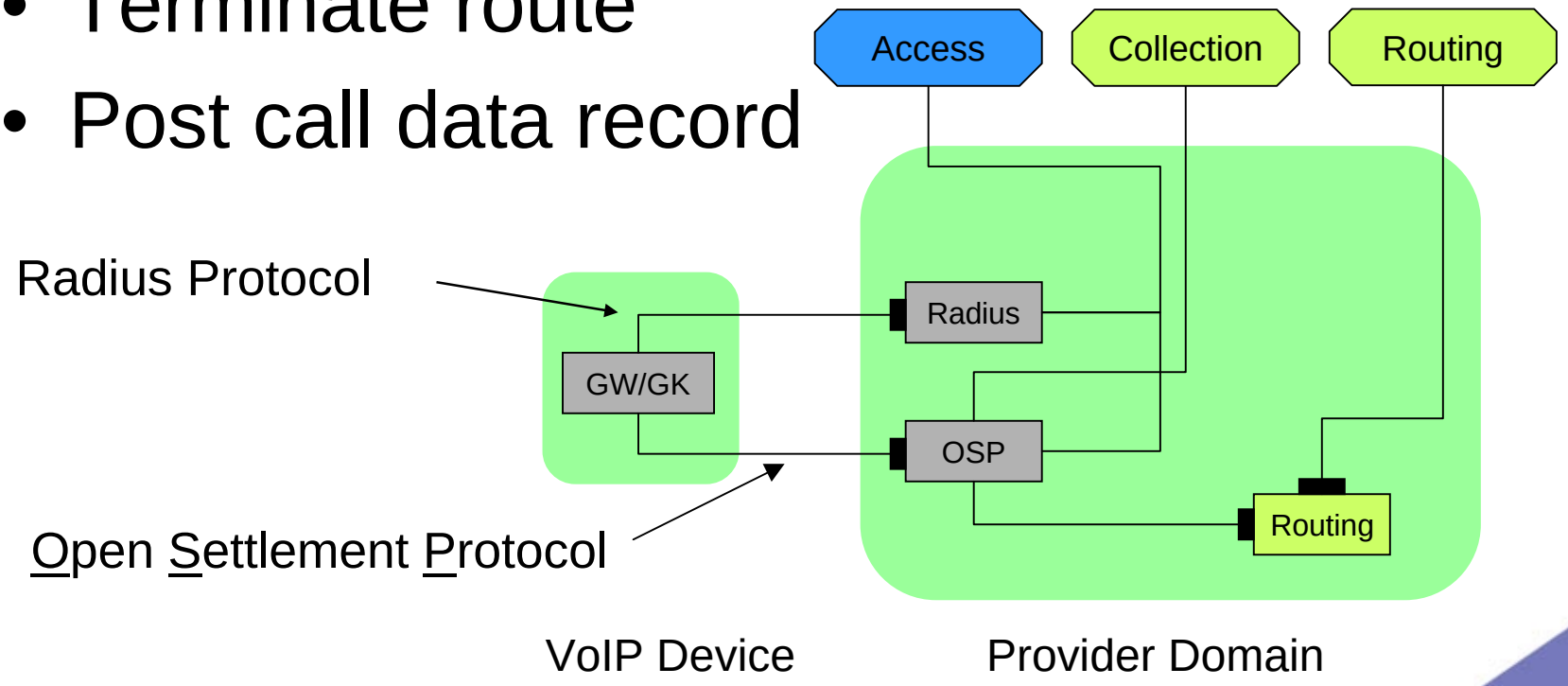
- User logs onto home domain
- User logs onto remote domain



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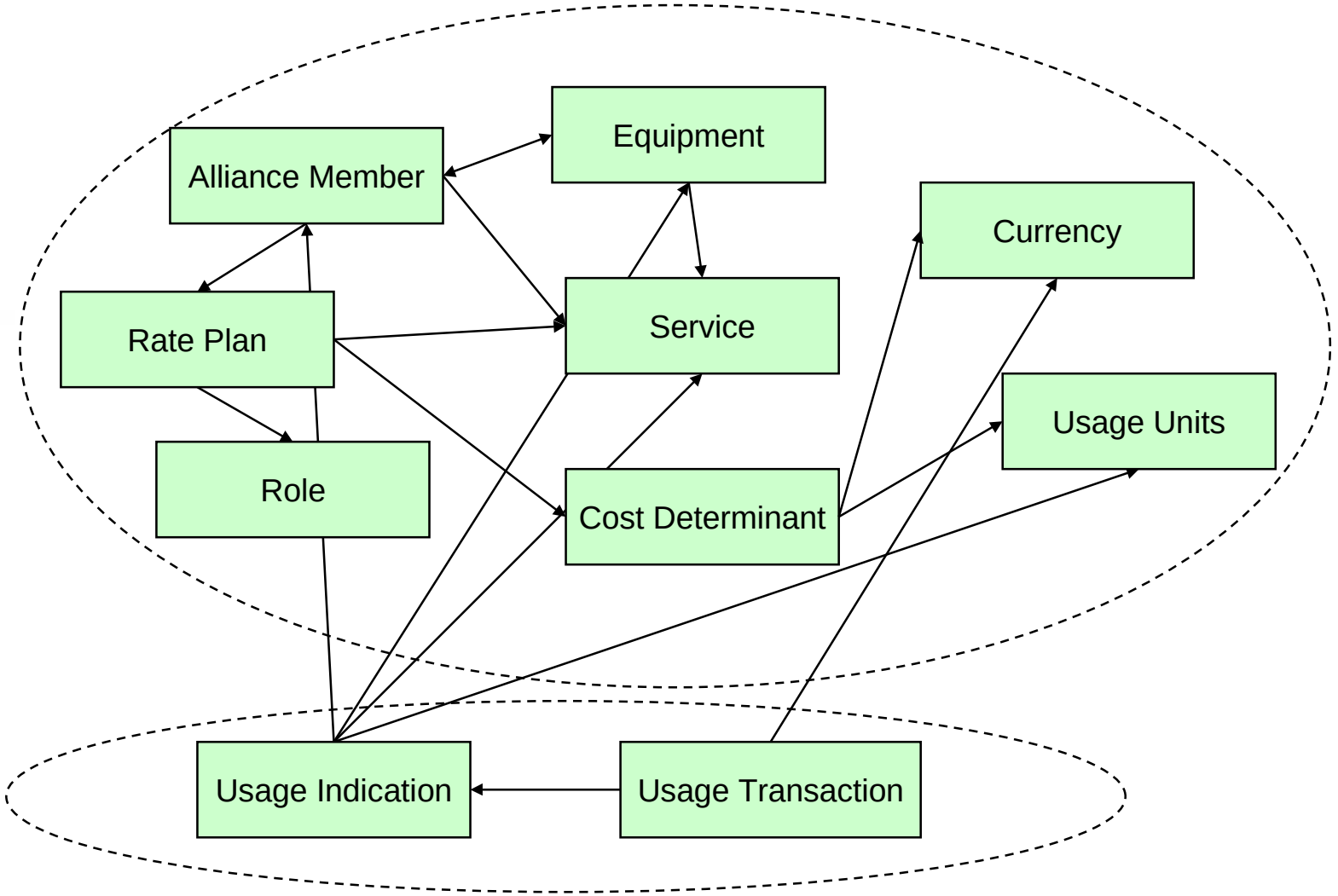
VoIP Service

- Authorize user
- Terminate route
- Post call data record



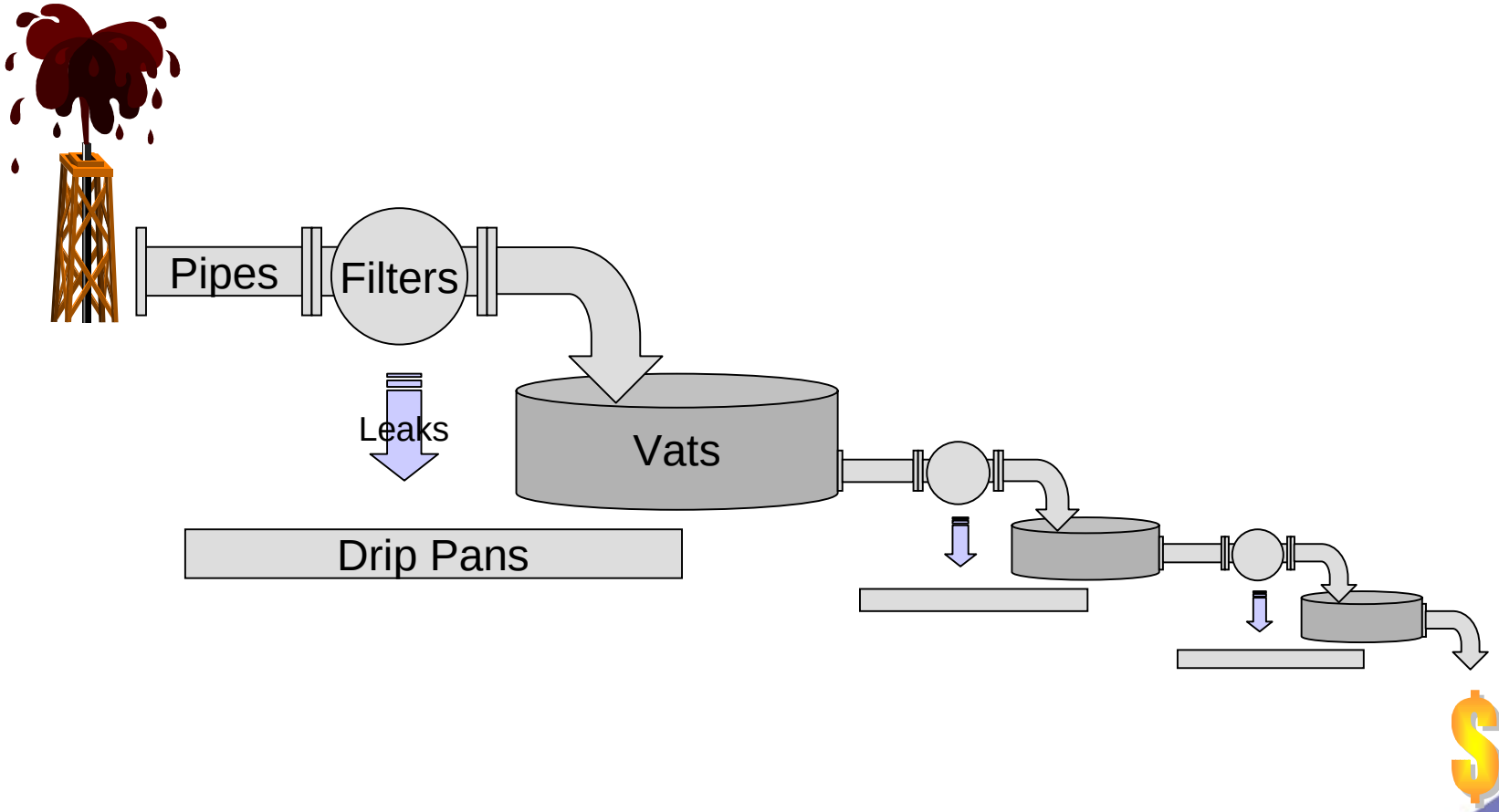
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Some Domain Objects



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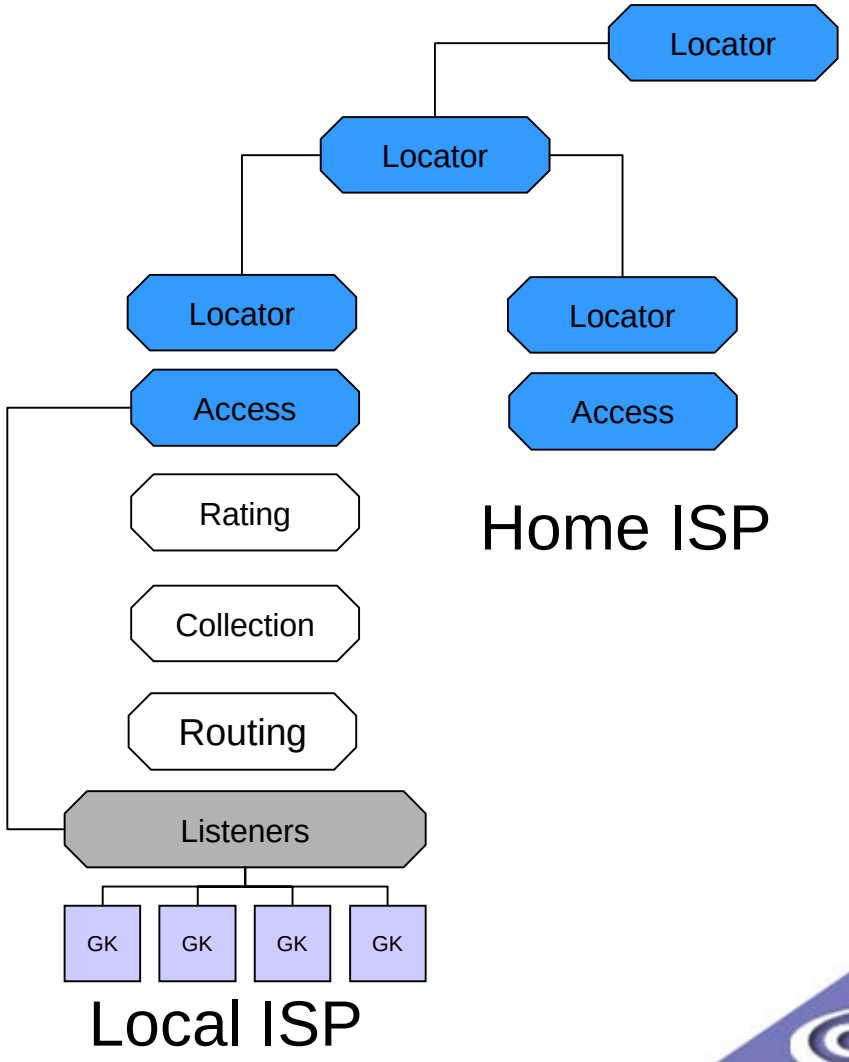
Usage Pipeline Metaphors



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Processing Phases

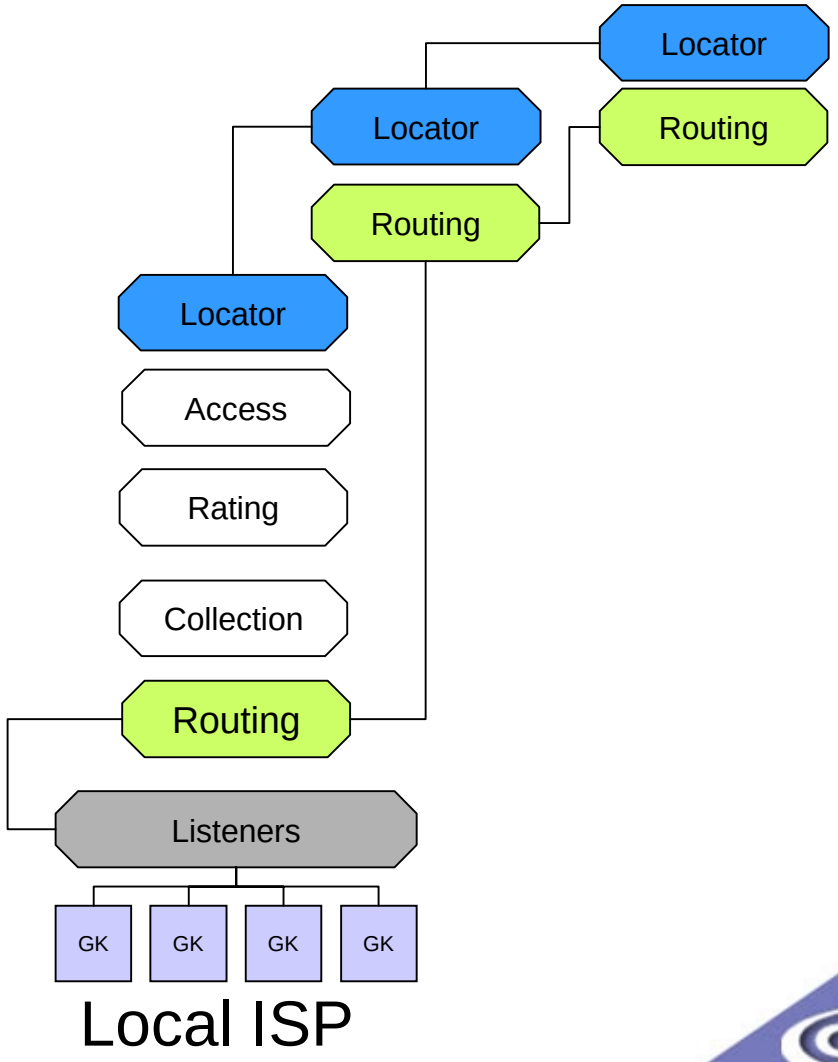
- *Authentication*
- *Authorization*



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Processing Phases

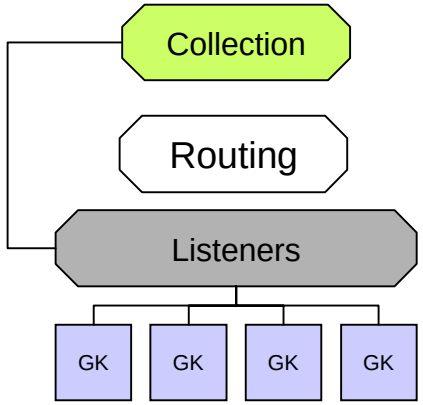
- Authentication
- Authorization
- *Routing*



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Processing Phases

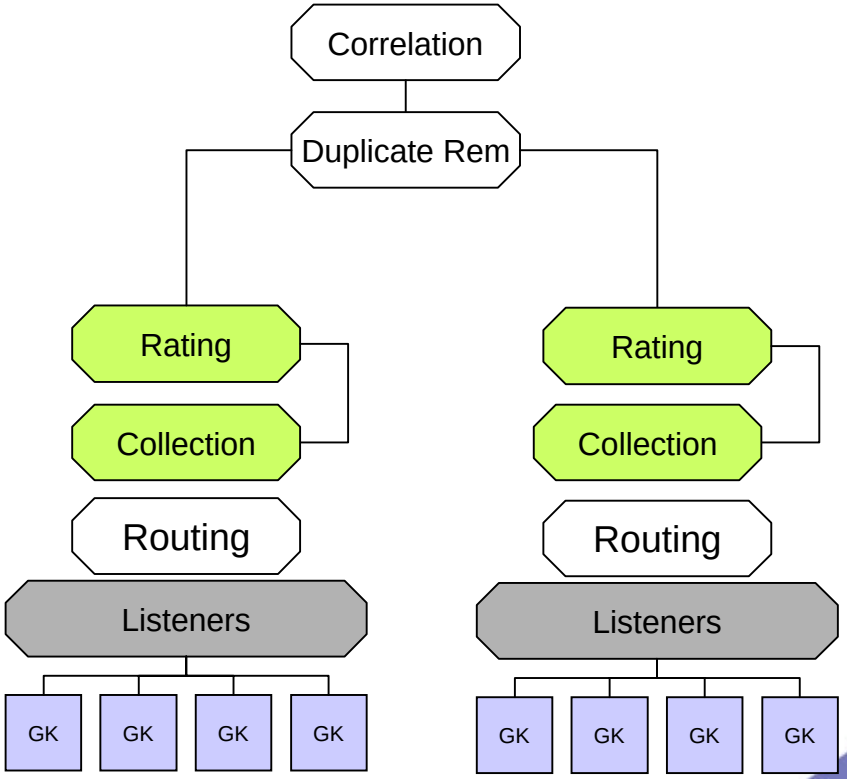
- Authentication
- Authorization
- Routing
- *Collection*



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Processing Phases

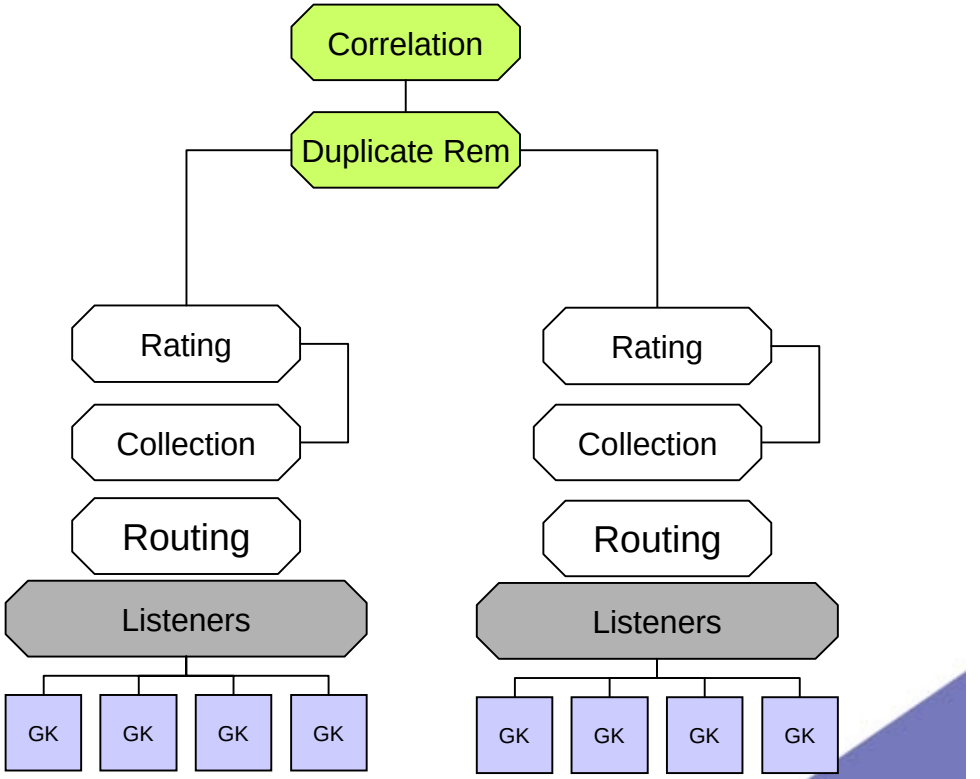
- Authentication
- Authorization
- Routing
- Collection
- *Rating*



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Processing Phases

- Authentication
- Authorization
- Routing
- Collection
- Rating
- *Duplicate removal*
- *Correlation*



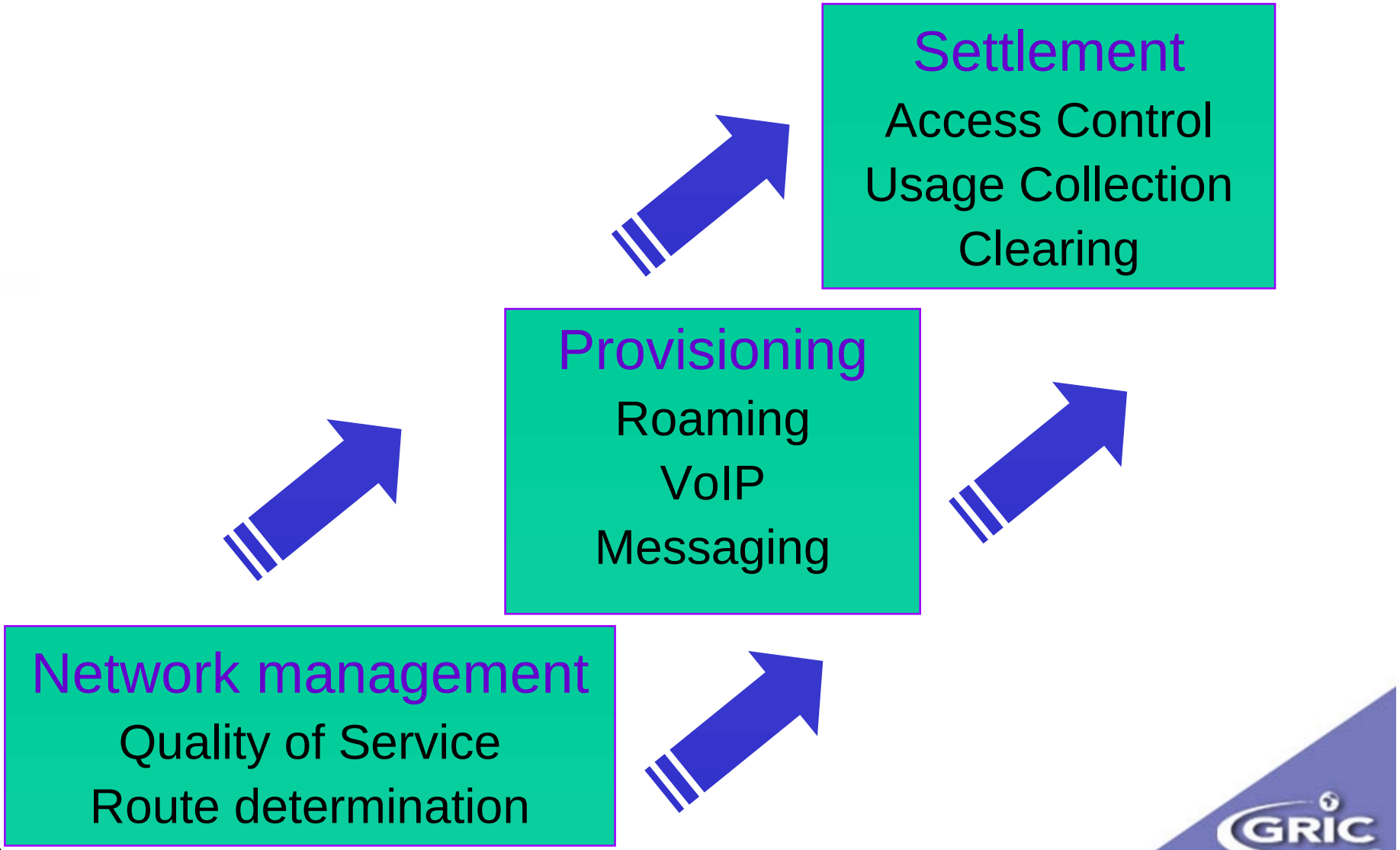
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How could you deploy them?

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Operations & Business Support Systems



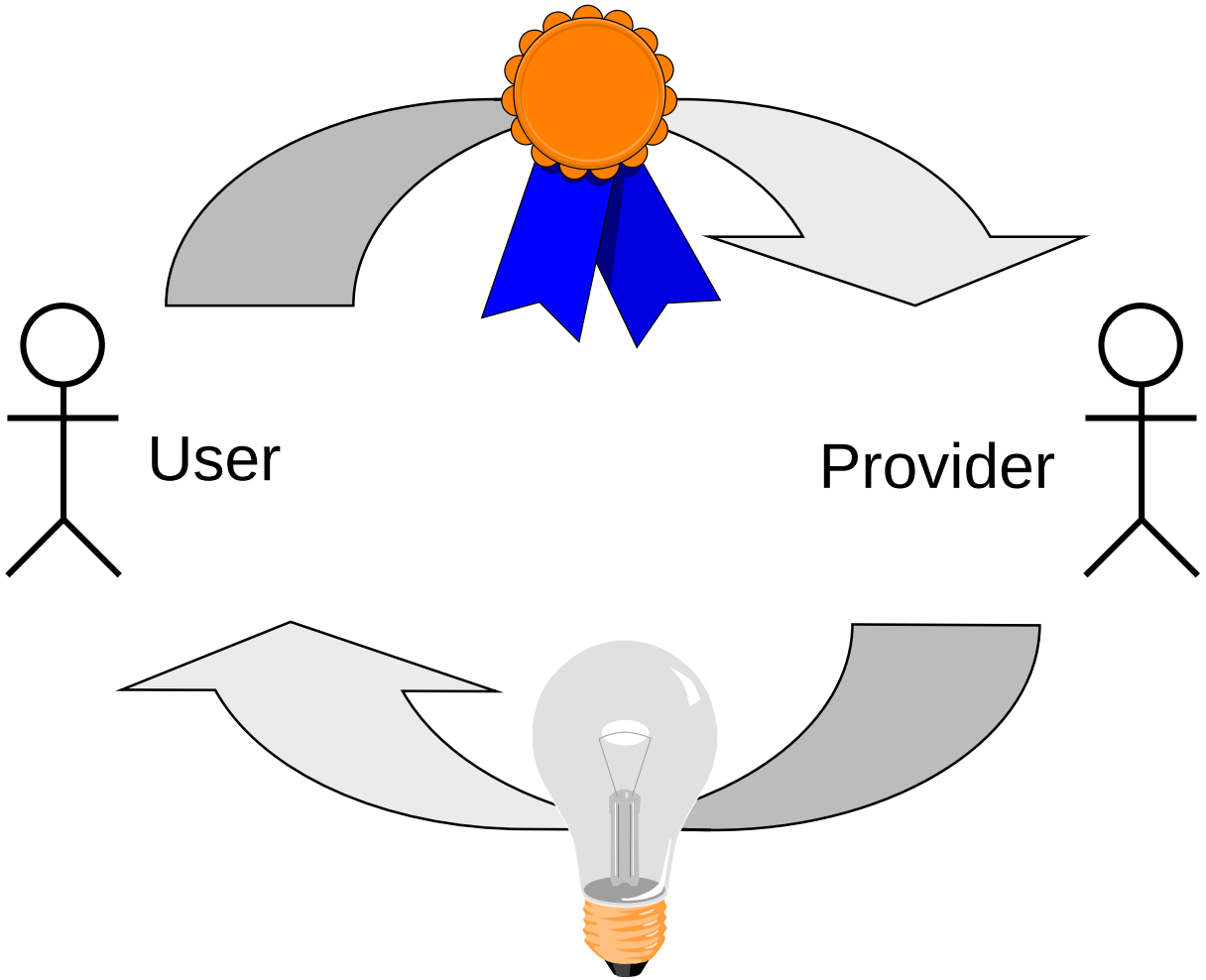
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Service Operational Challenges

- Organize & package value added services
- Manage a complex distributed environment
- Ensure reliability and availability
- Support ongoing application evolution
- Scale to meet demand

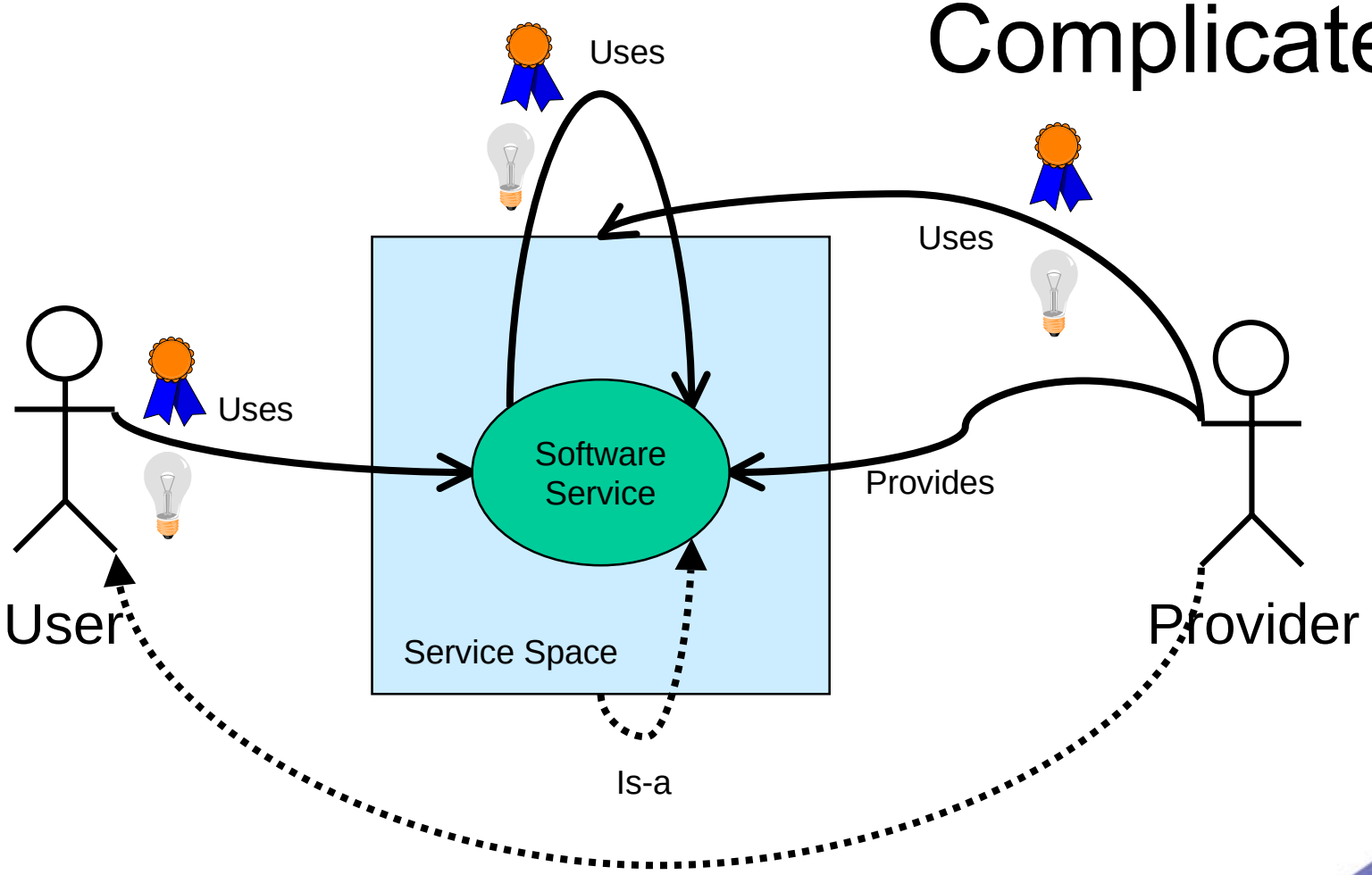
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Services are Fundamental



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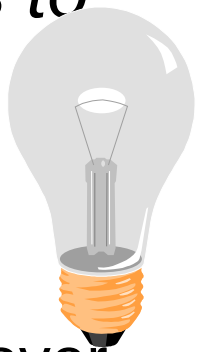
Software Services are More Complicated



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Operations Support Systems

- *Provisioning of services from providers to consumers*
- Processes vs. containers/capsules
- Service Lifecycle
  - Start, termination, monitoring, restart, fail-over, migration, …
- Component/service management
  - Instantiation, introduction, termination, POPs, …
- Examples



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Processes vs. Containers & Capsules

- Component's runtime environment
- Process (OS mechanism)
  - basic file and I/O services
- Capsule (light weight)
  - distribution services only
- Container (heavy weight)
  - distribution, transactions, persistence, naming

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Service Component Lifecycle

- Installation and de-installation
- Component startup, shutdown & monitoring
- Component restart, fail-over, migration

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Service Lifecycle

- Service instantiation
  - component introduction
  - service introduction
- Service provisioning & monitoring
- Service termination

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Examples

- EJB
- Jiro
- TINA-DPE (Aero)

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Business Support Systems

- *Compensation for service usage from customer to provider*
- Service architectures
- Example



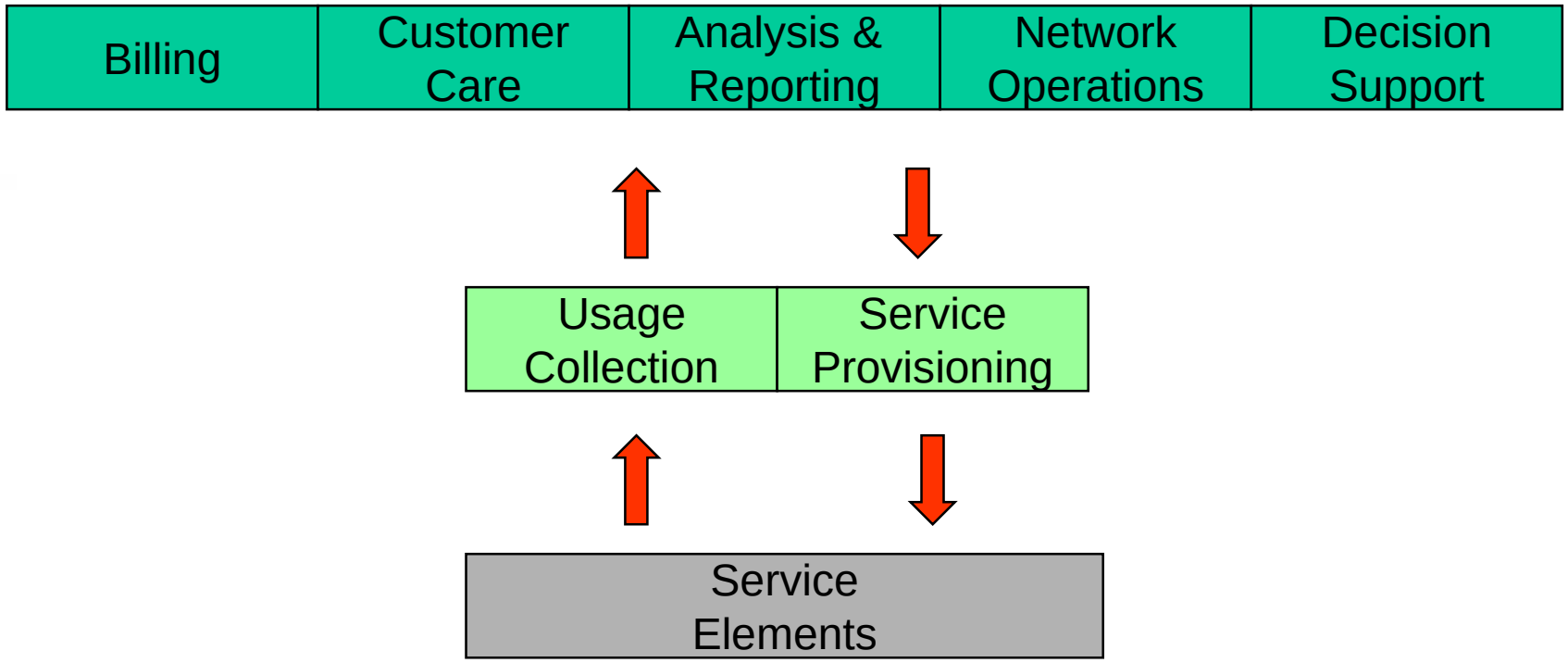
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Accounting Challenges in IP Settlement &Billing

- **World-wide IP services**
- **Rating, currency by countries**
- **Risk management / hedging by partners**
- **Standard Protocols**
  - **TCP/IP, Radius**
  - **HTTP, XML, OSP**
  - **CORBA, COM, RMI**

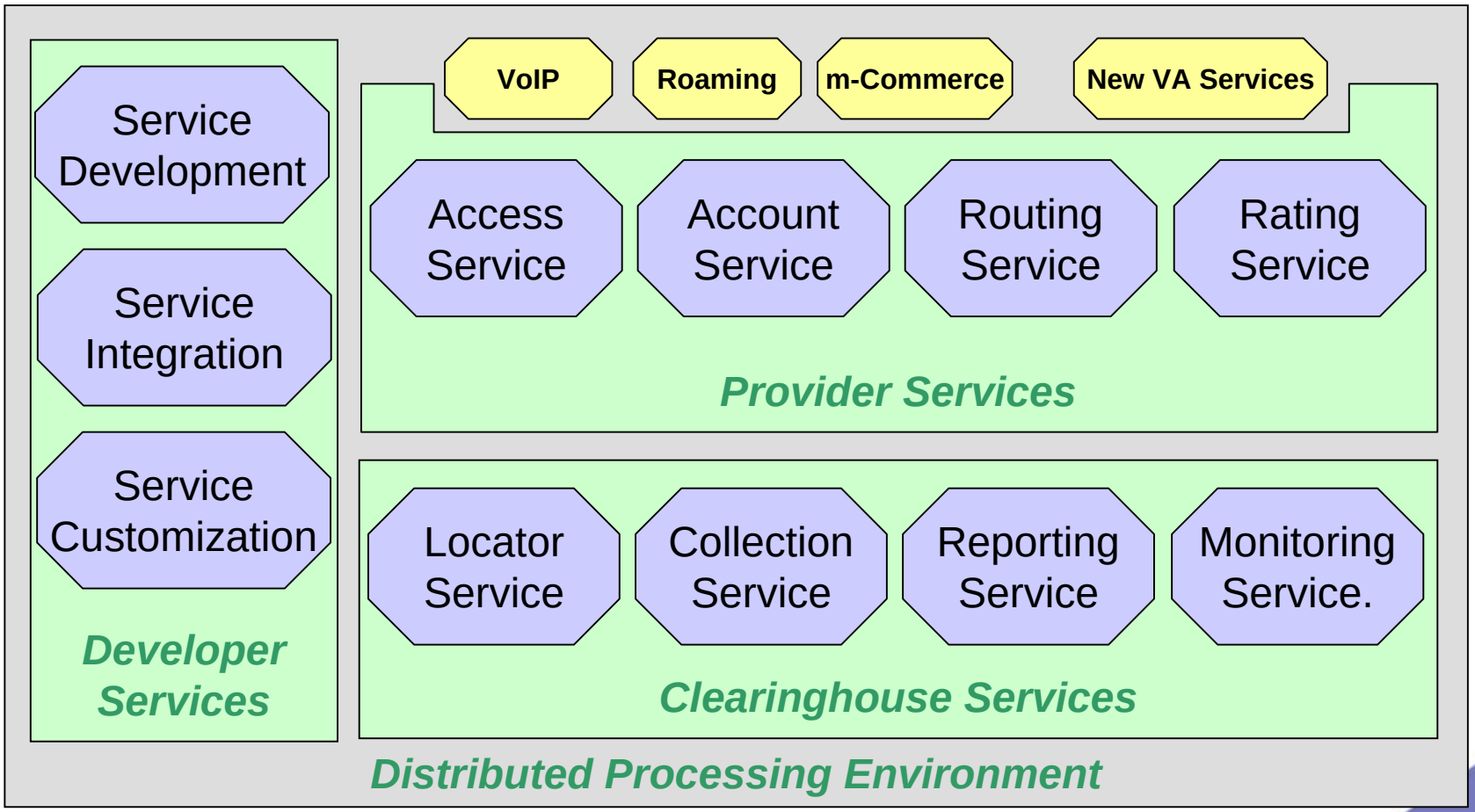
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Business Support Services



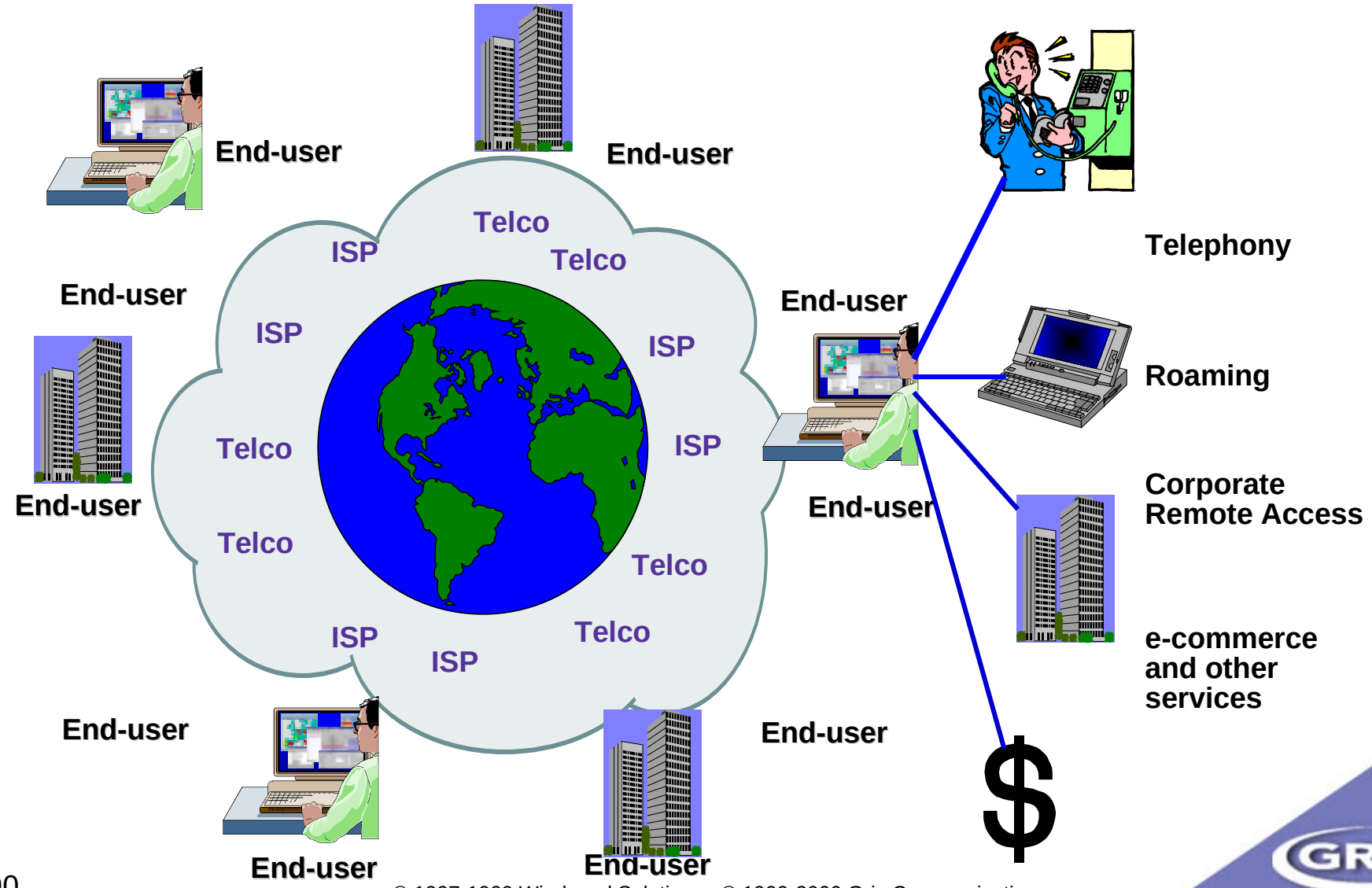
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Convergent Services Platform



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A Worldwide Alliance Network



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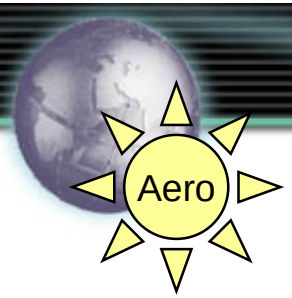




How do we deploy it?



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Introducing Aero

- A management environment for complex distributed services
  - Service description & generation
  - Centralized domain management
  - Decentralized node management
  - Application monitoring & control
  - Managed application evolution
  - CORBA, TINA & Java standards

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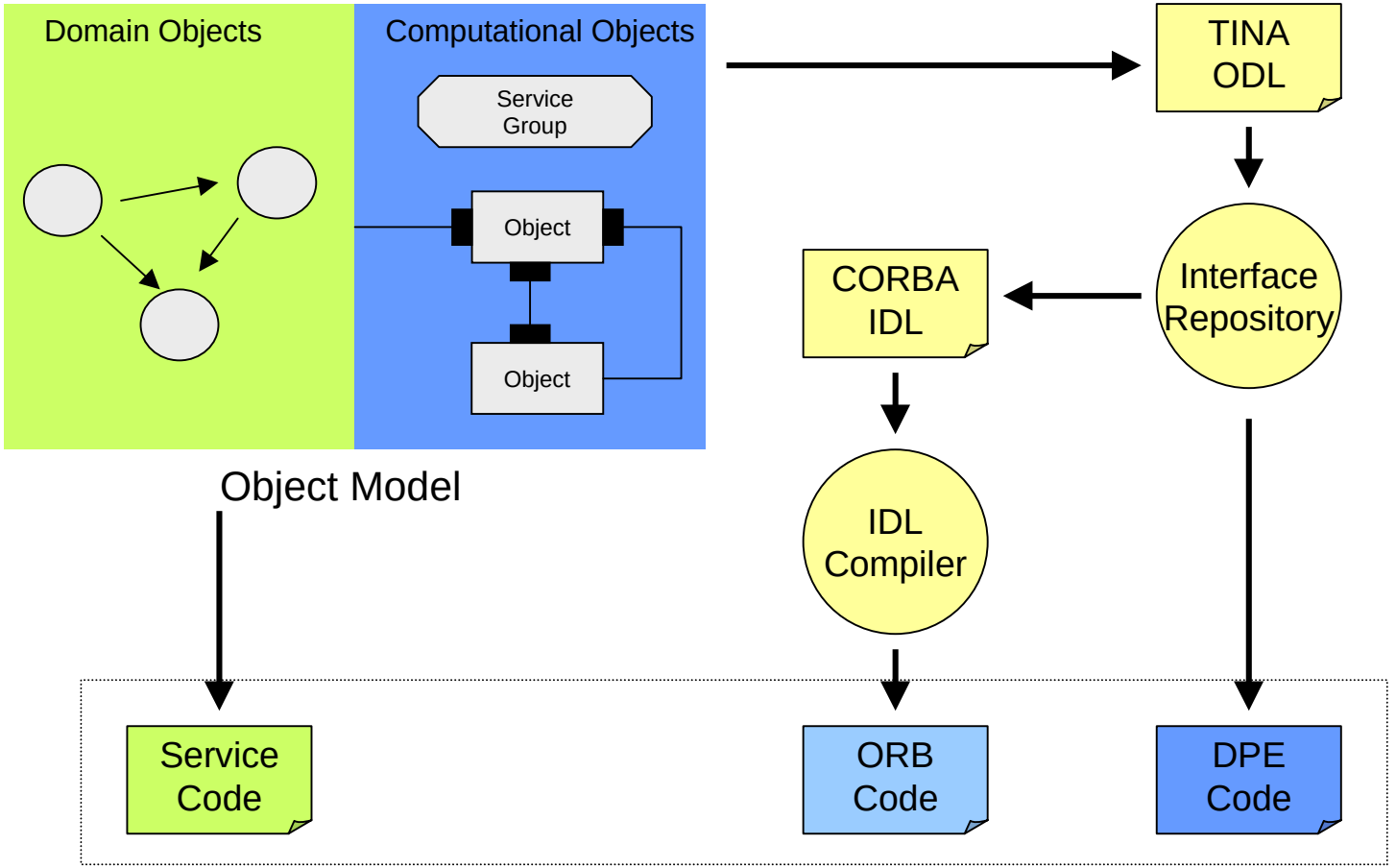
Will it Scale? To a Point, but…

- We have enough chaos in the NOC for now
- Our users are asking for more management control, not less
- Better administration facilities will help keep us in business while we figure out how to scale them further



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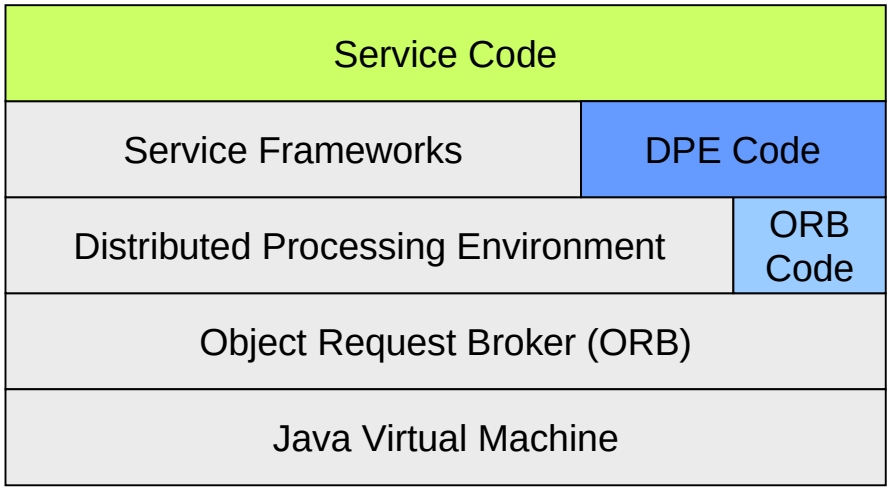
Aero Service Development



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Target Deployment Platform

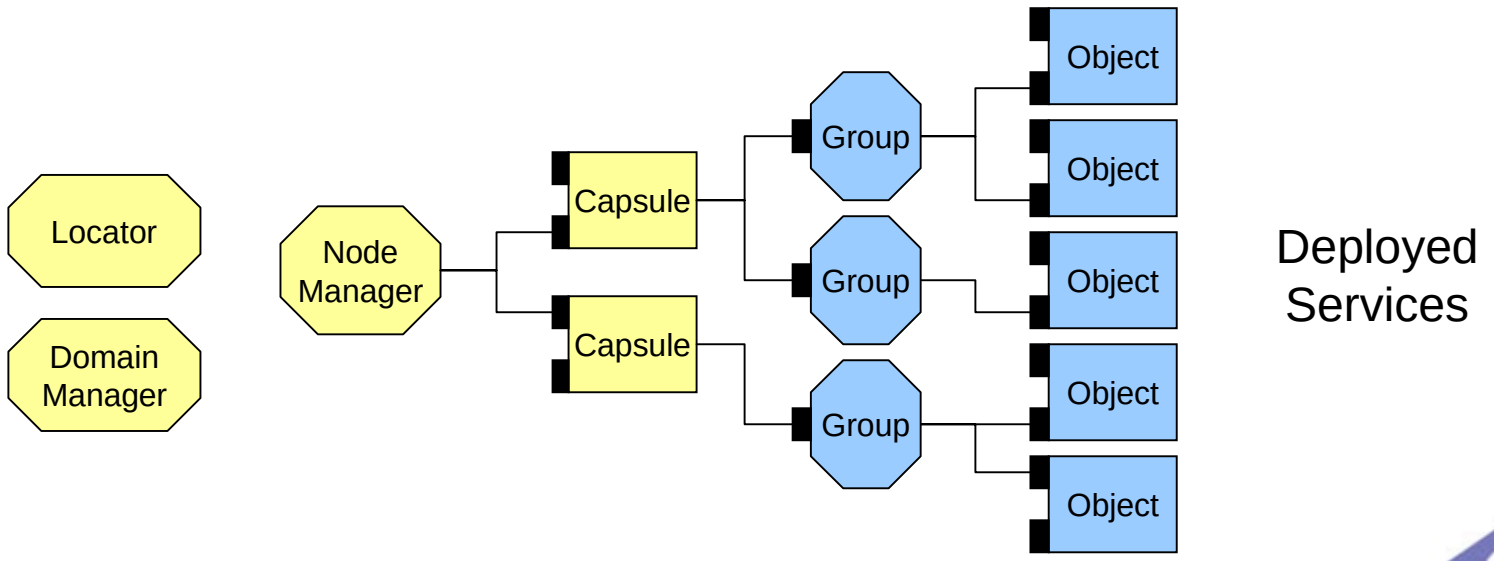
- Java for portability, productivity
- CORBA for interoperability
- TINA for service architecture



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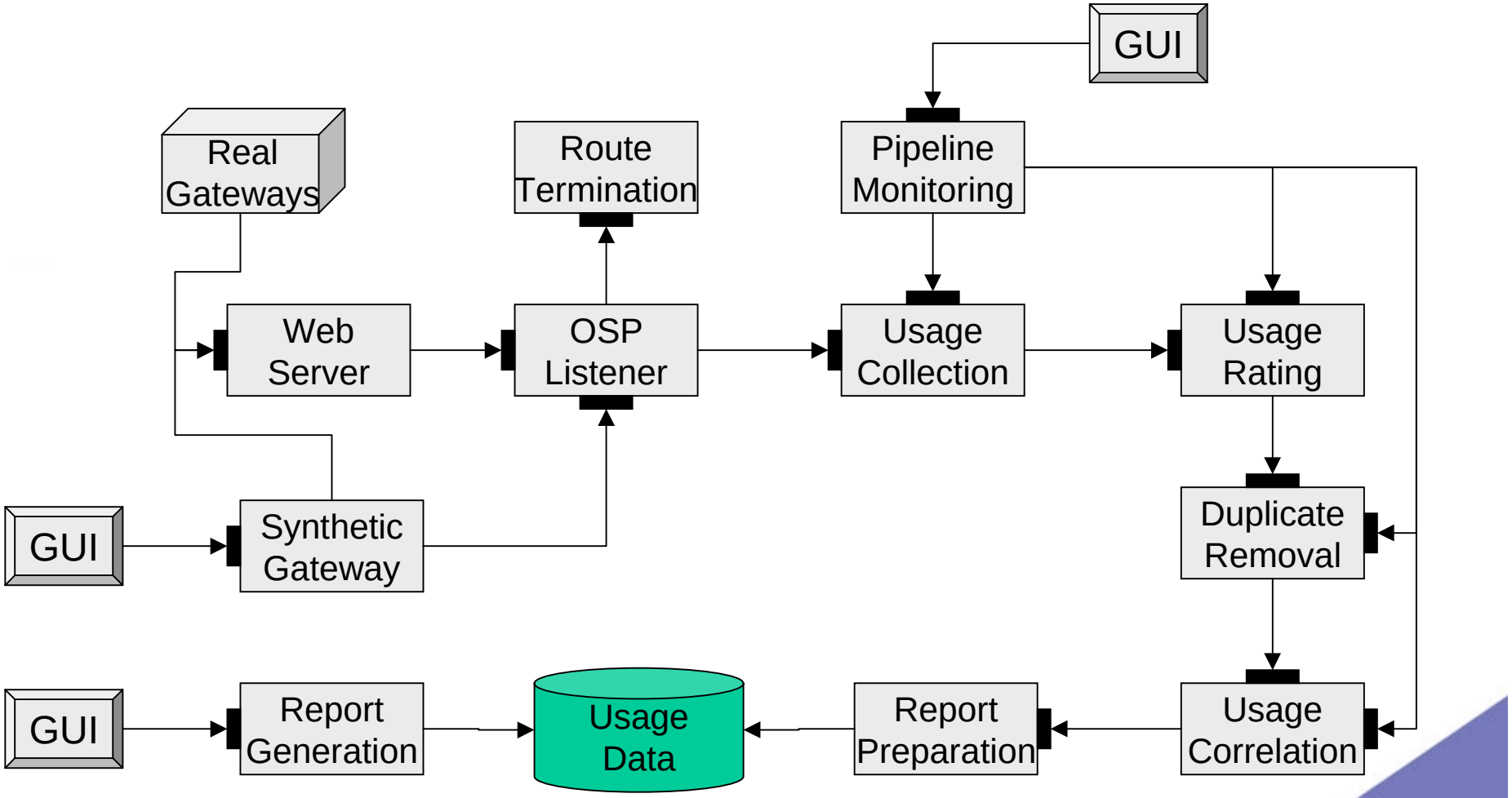
Distributed Processing Environment

- Domain Manager deploys service components
- Node Managers launch service capsules
- Domain Manager instantiates service groups
- Locator & groups provide introduction context



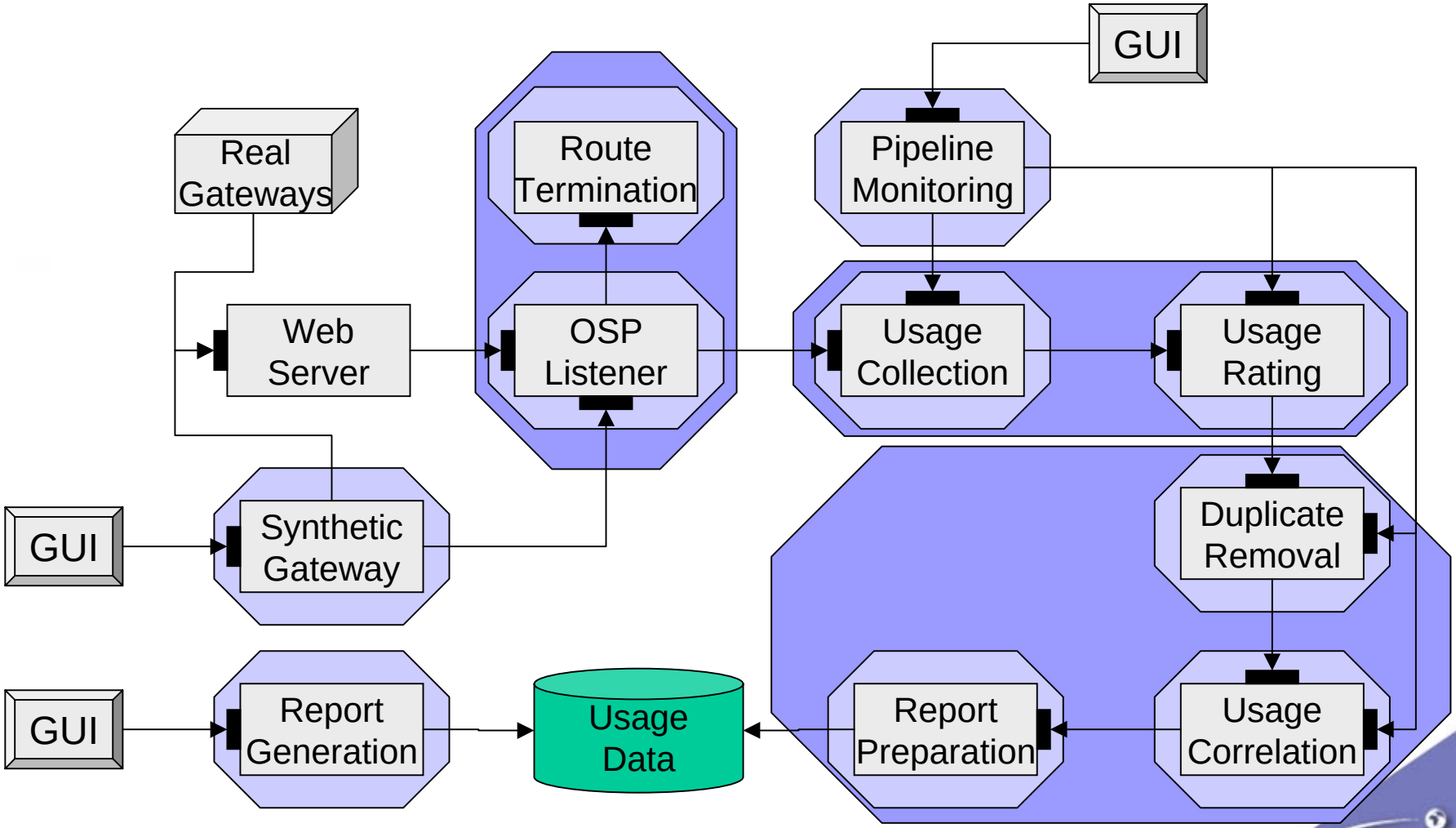
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Pipeline Computational Objects



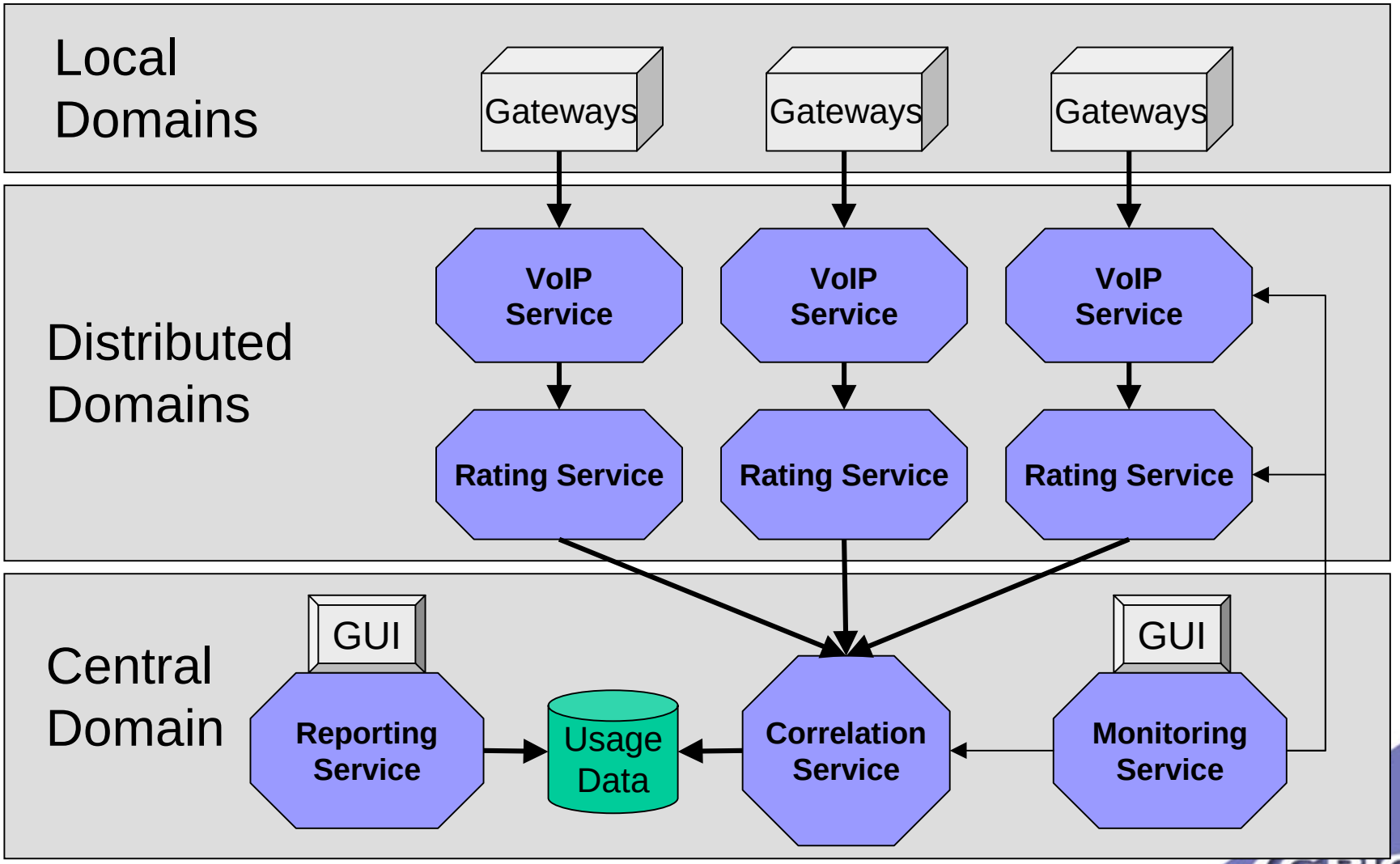
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Pipeline Service Groups



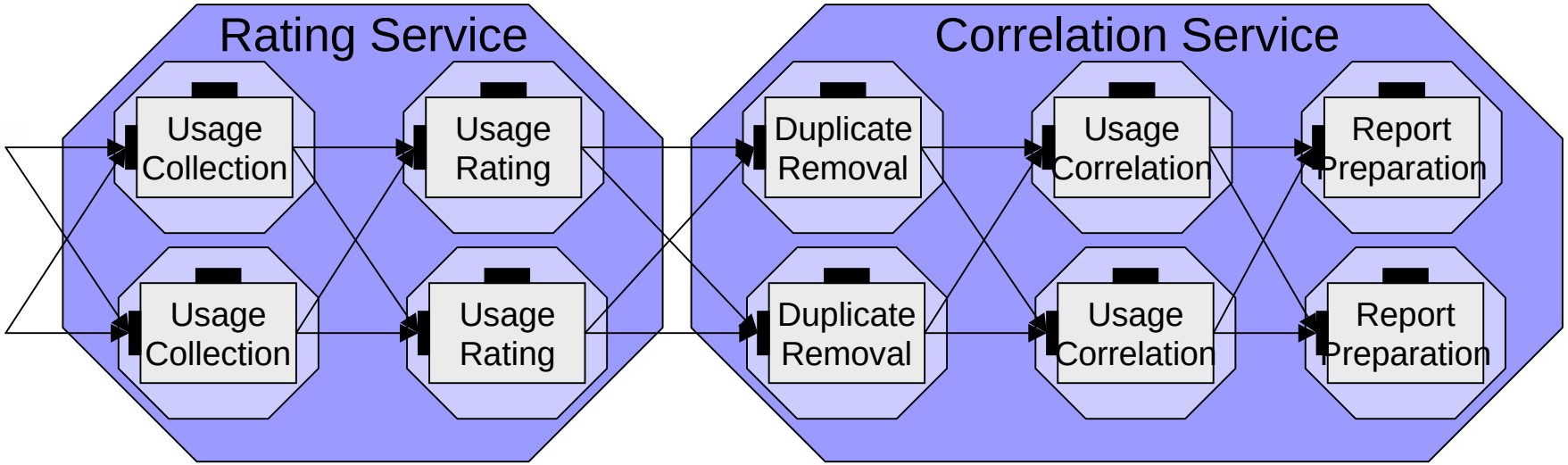
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Multiple Service Groups



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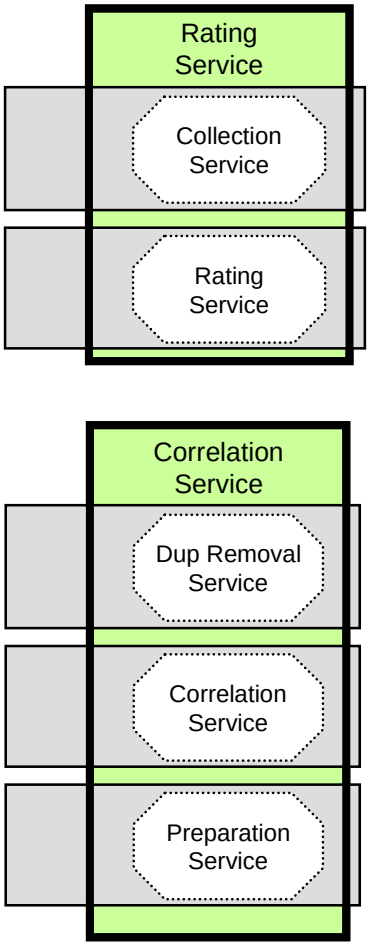
Redundant Service Components



- *High Availability*
- *Automatic Failure Recovery*
- *Improved Scalability*

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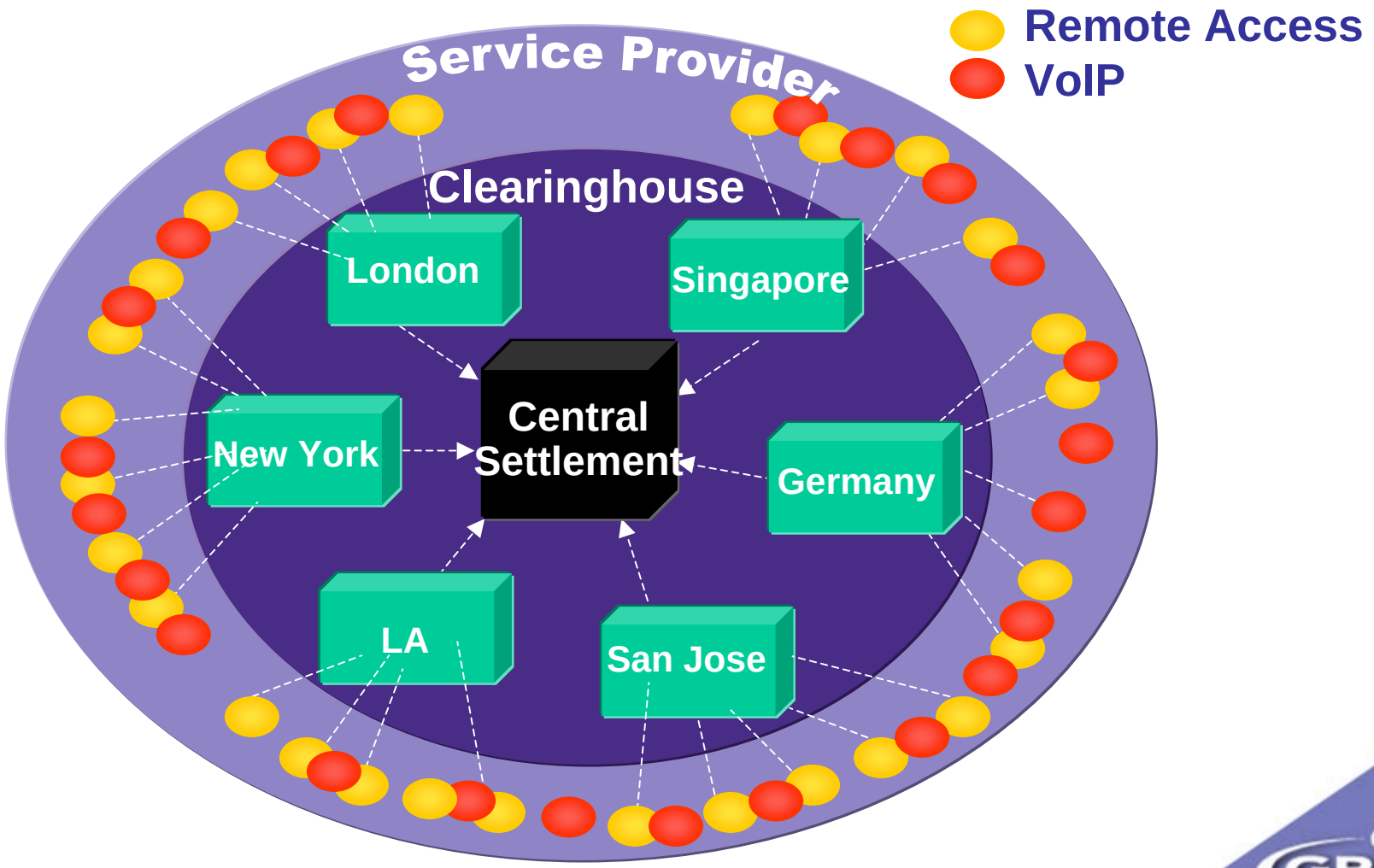
Services and Components



- One Rating Service includes multiple Collection service components and multiple Rating service components
- There may be multiple instances of Rating Services running
- The Correlation Service has multiple Duplicate Removal, Correlation and Preparation service components
- The Correlation service requires at least one Rating Service to operate
- All Services must run on a variety of platforms (e.g. Sun, HP, Intel)

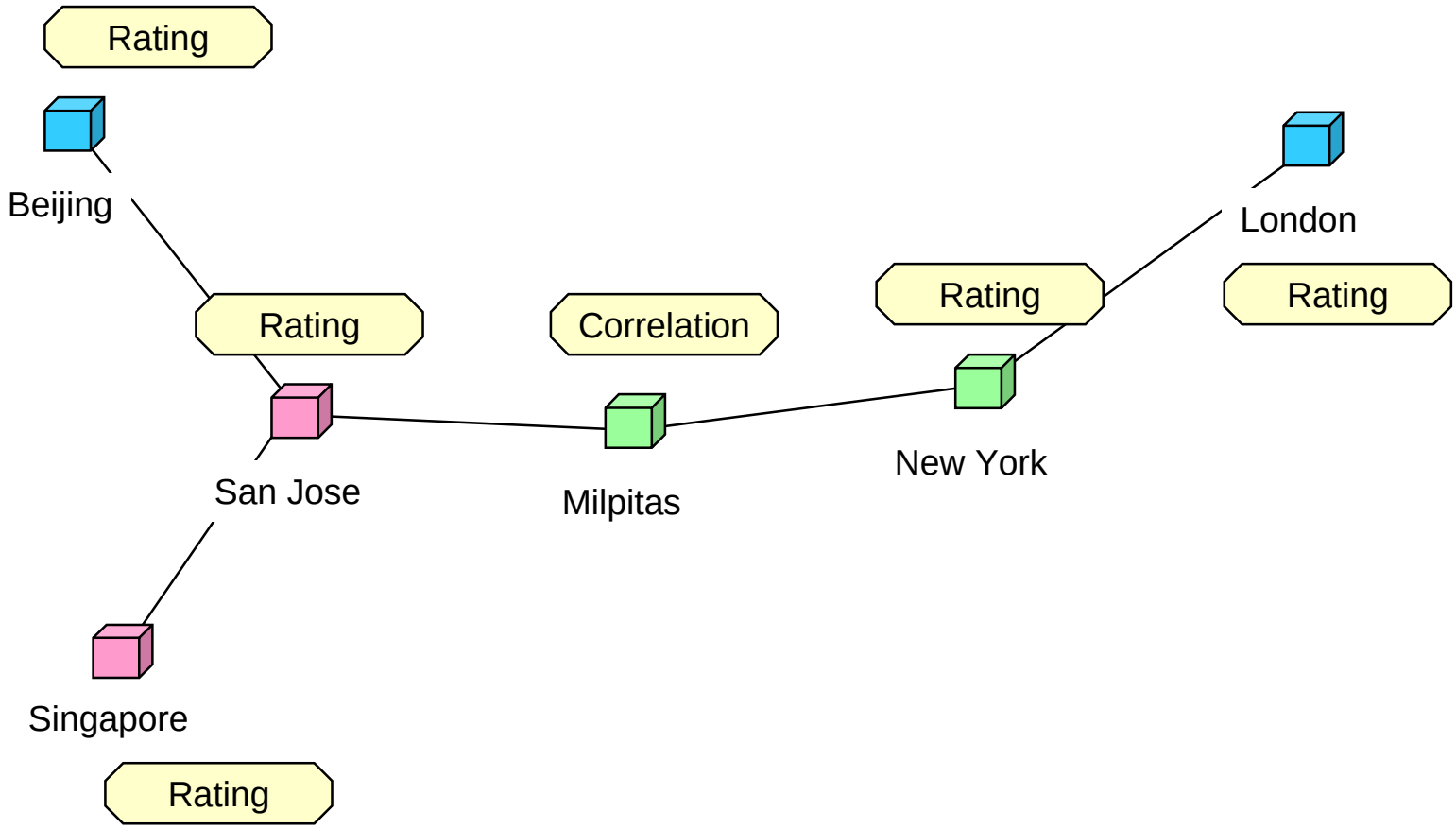
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Global Service Environment



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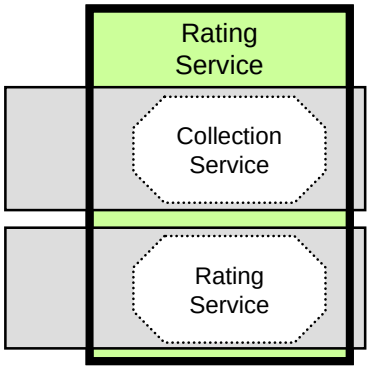
GRIC Clearinghouse Domain

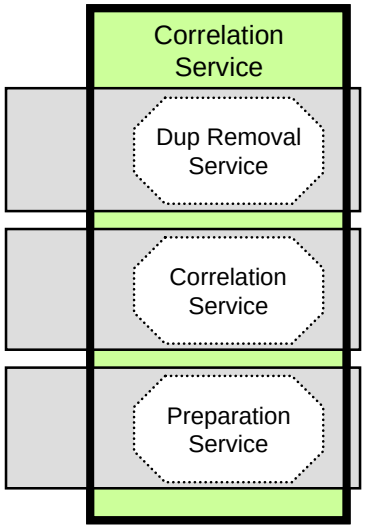


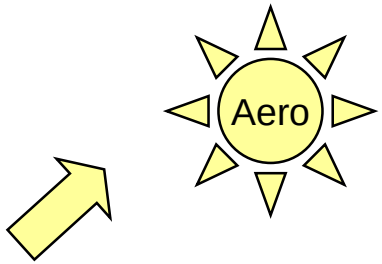
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Service & Node Management

Service Definitions
Service Components



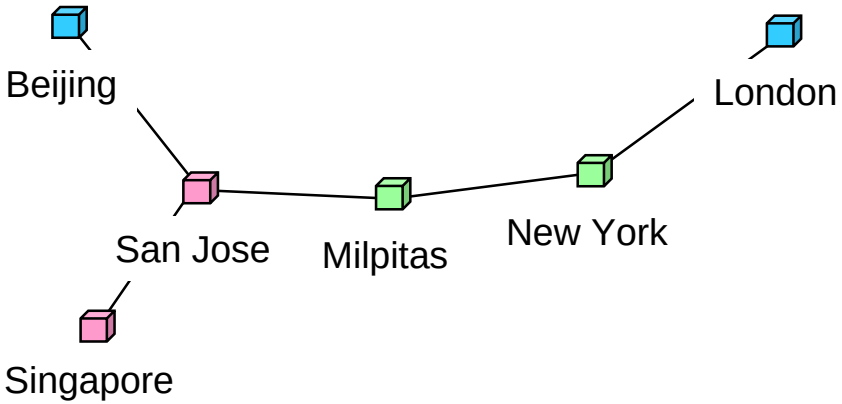




Node Information

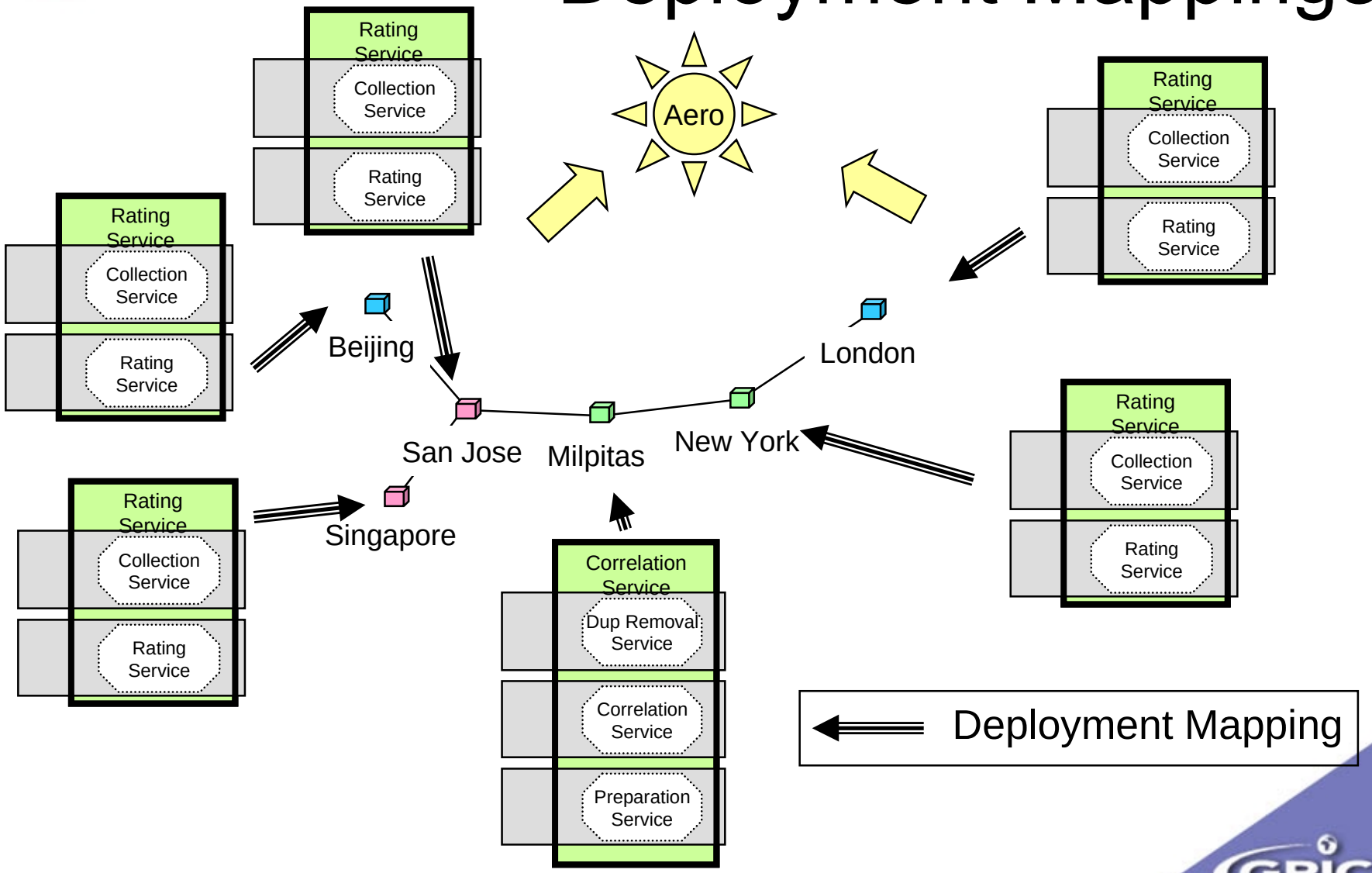
- Hardware
- Operating System
- Network
- Other

- NT
- Solaris
- HP-UX



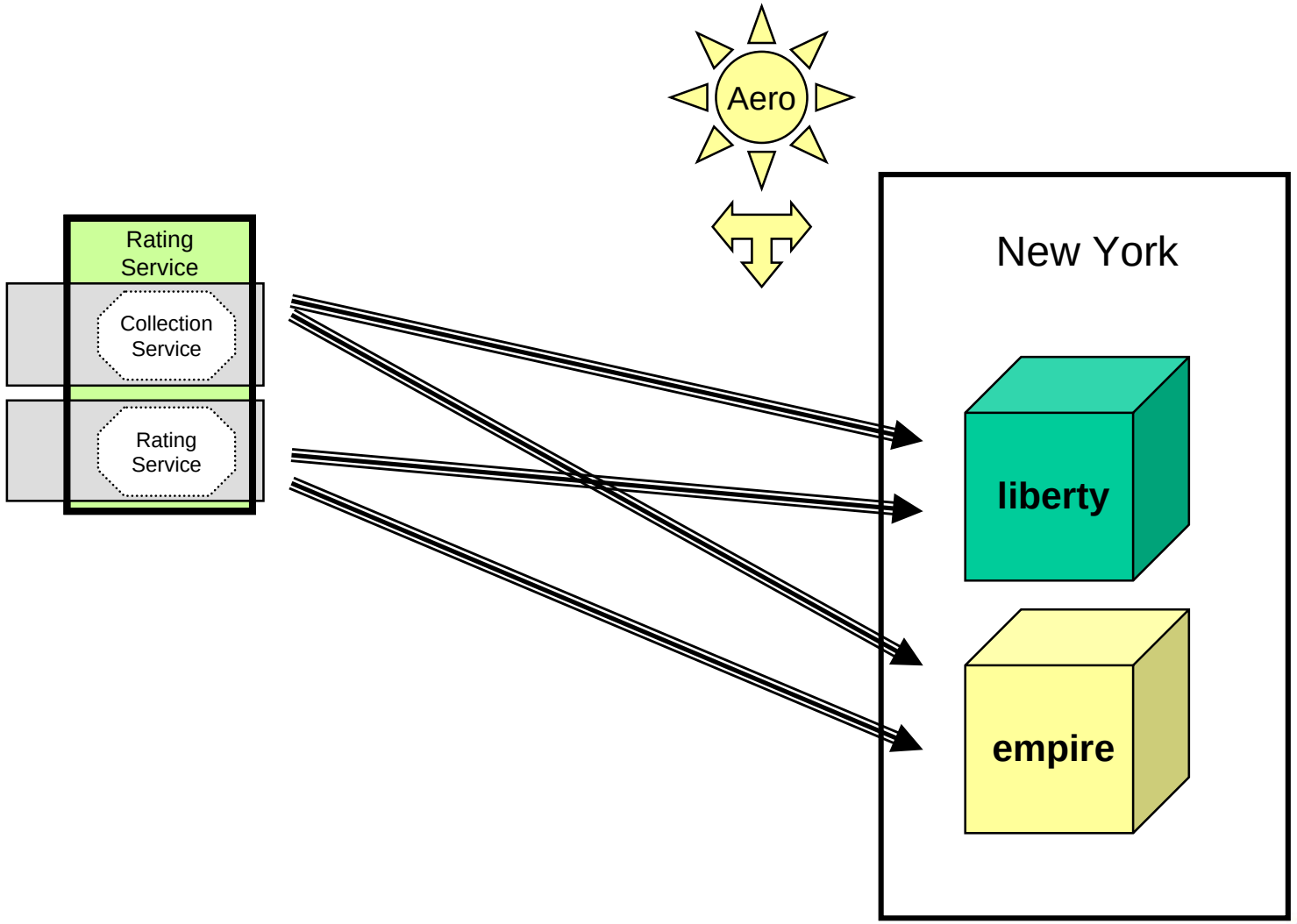
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Deployment Mappings



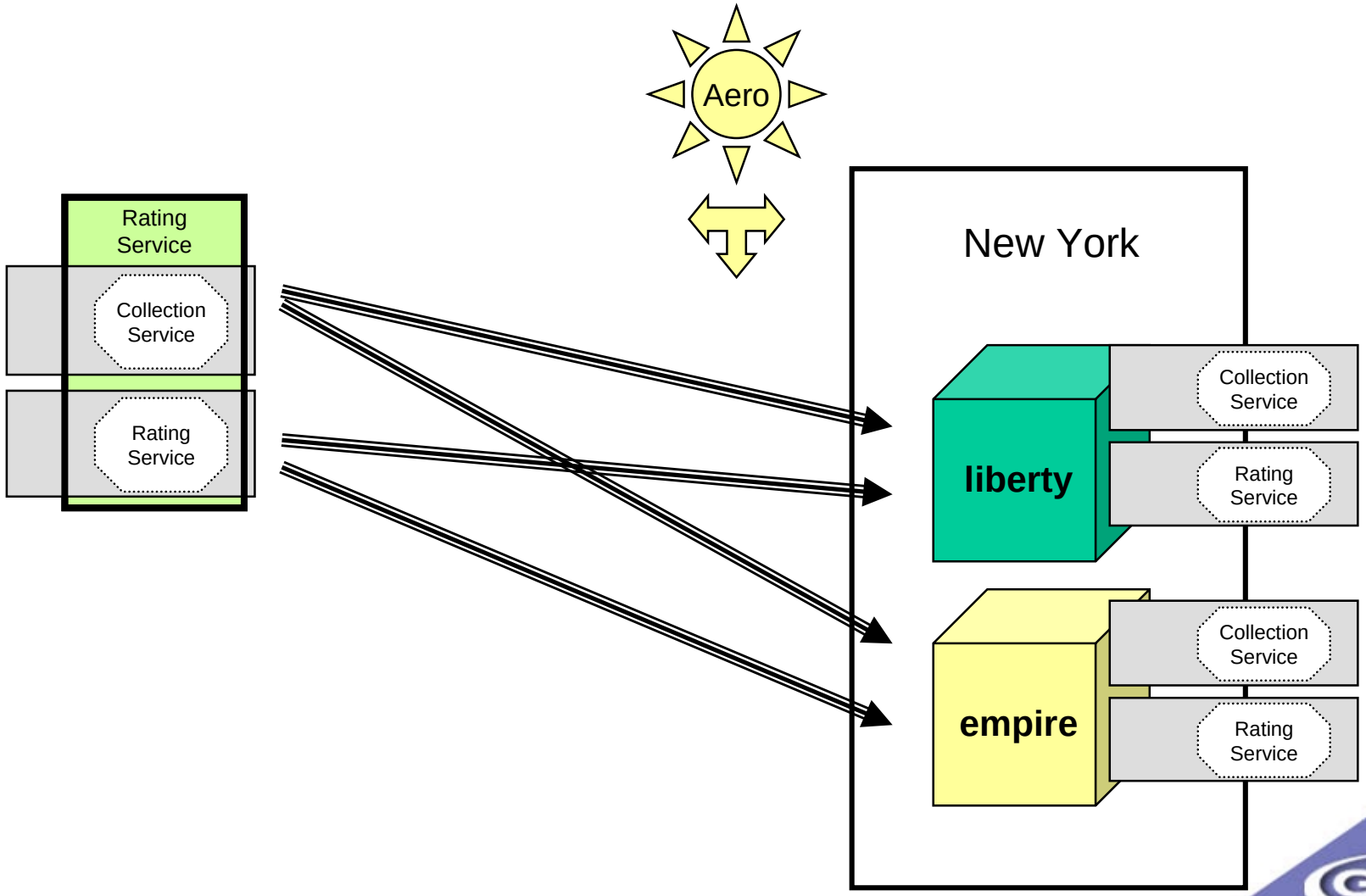
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Deployment Mapping Detail



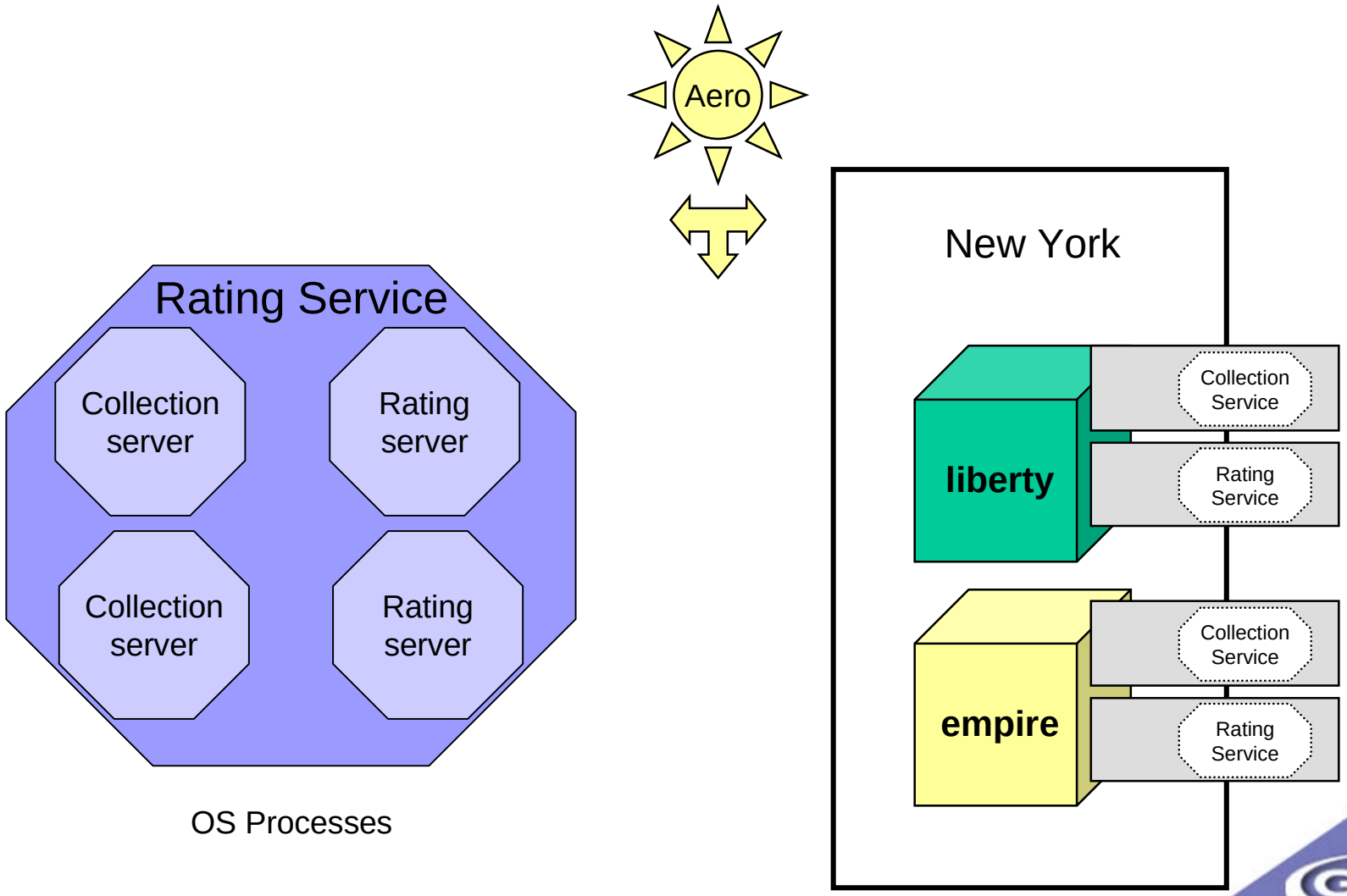
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Component Installation



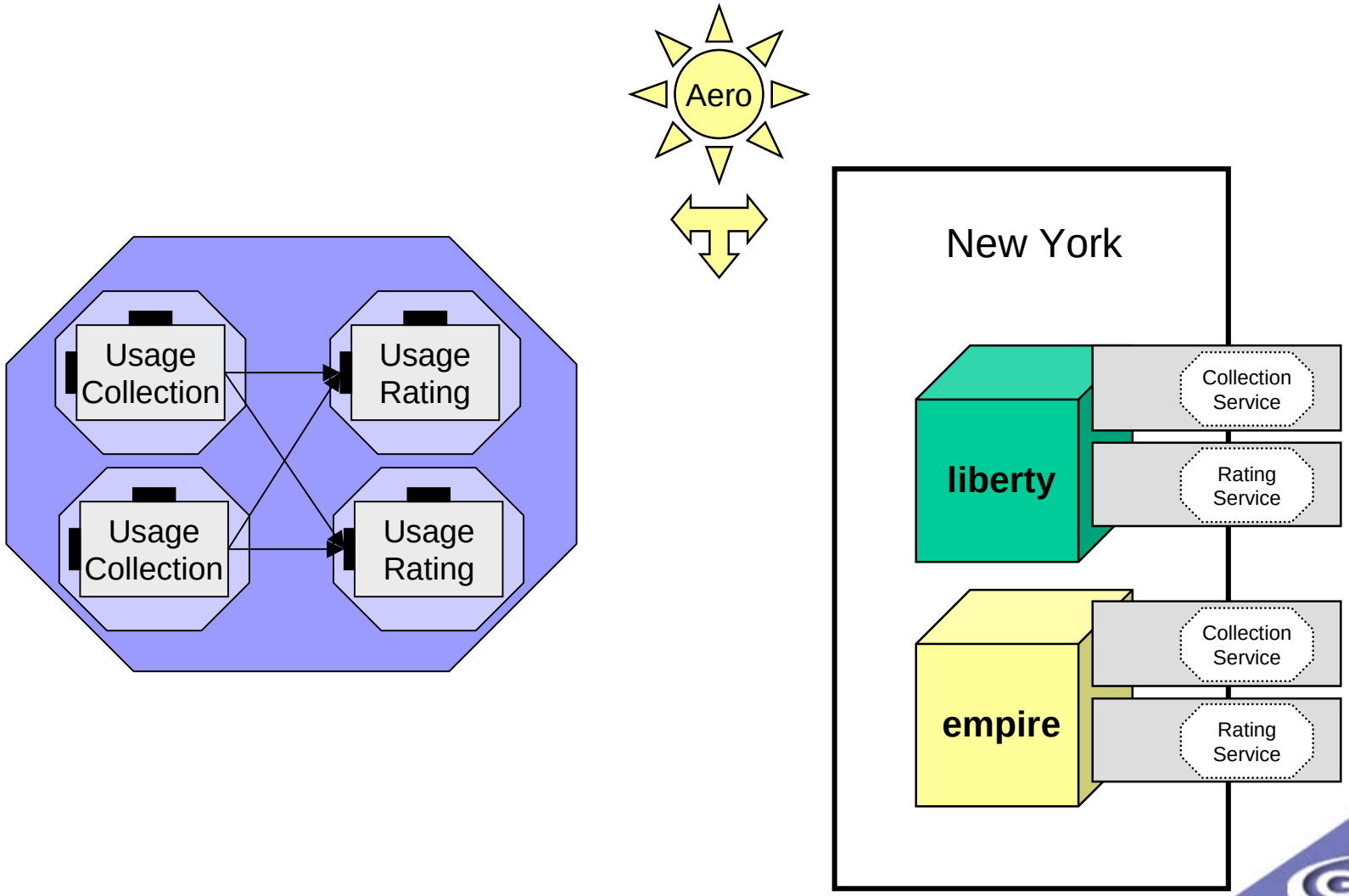
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Service Activation



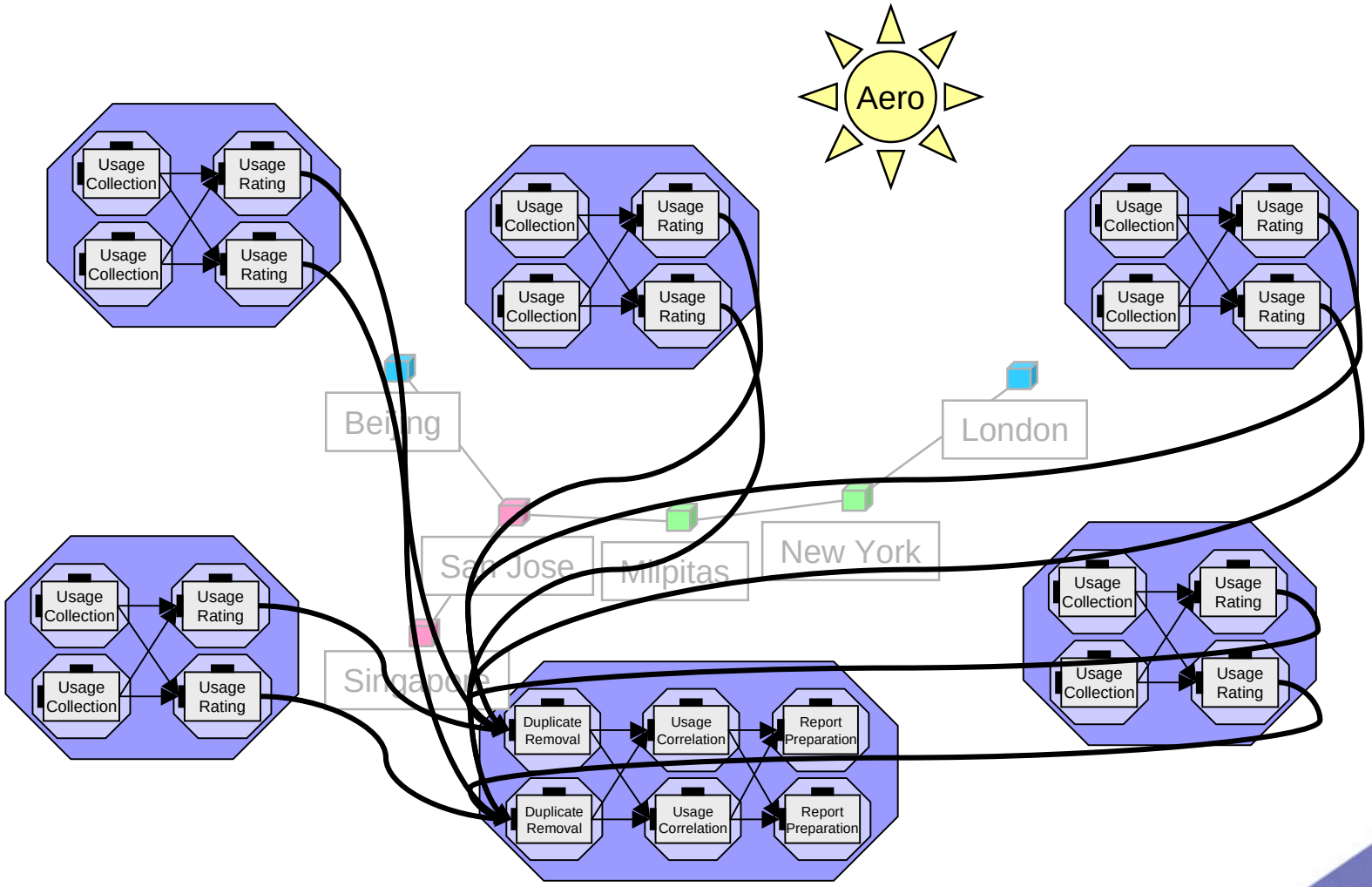
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Service Instantiation



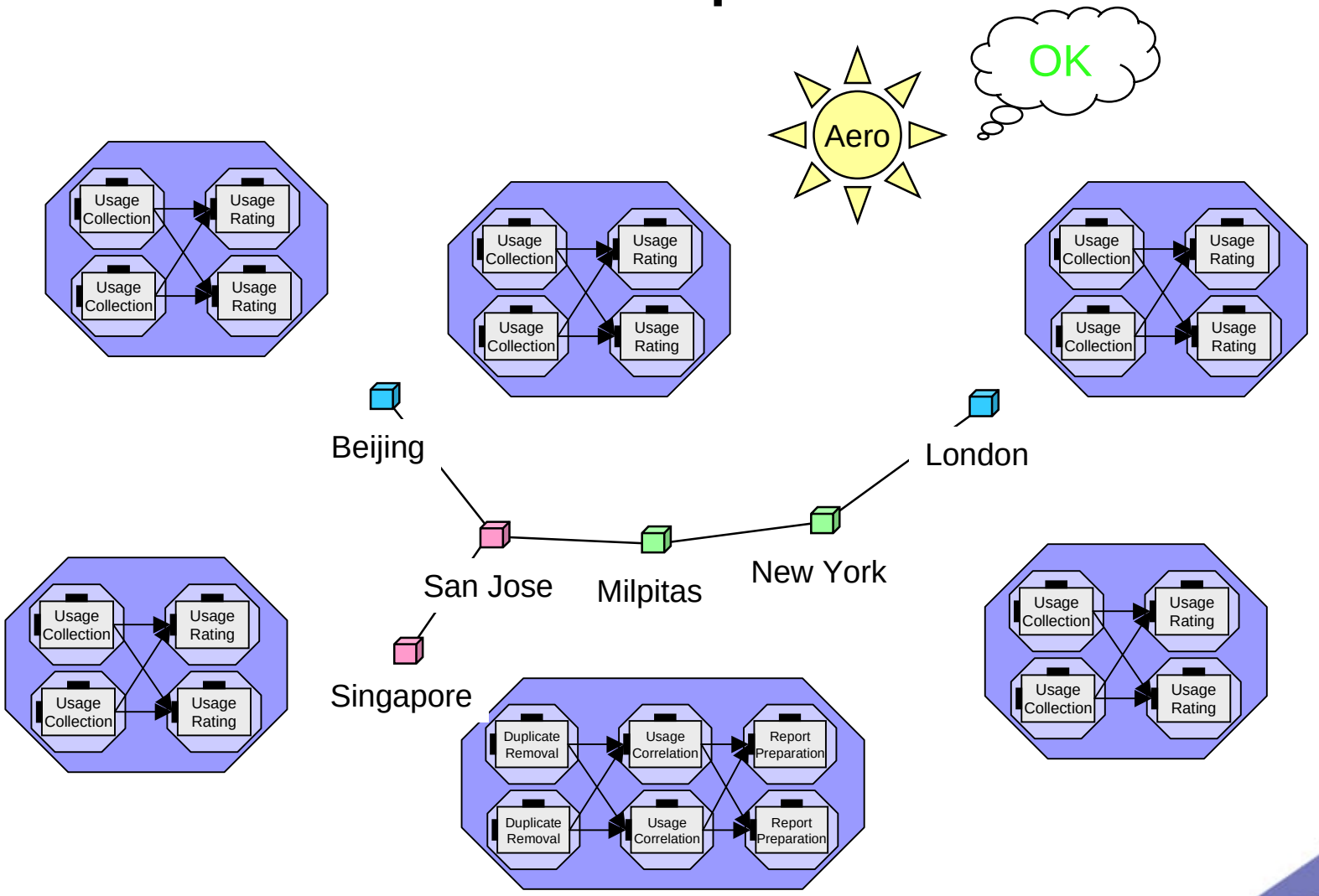
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Fully Instantiated Services



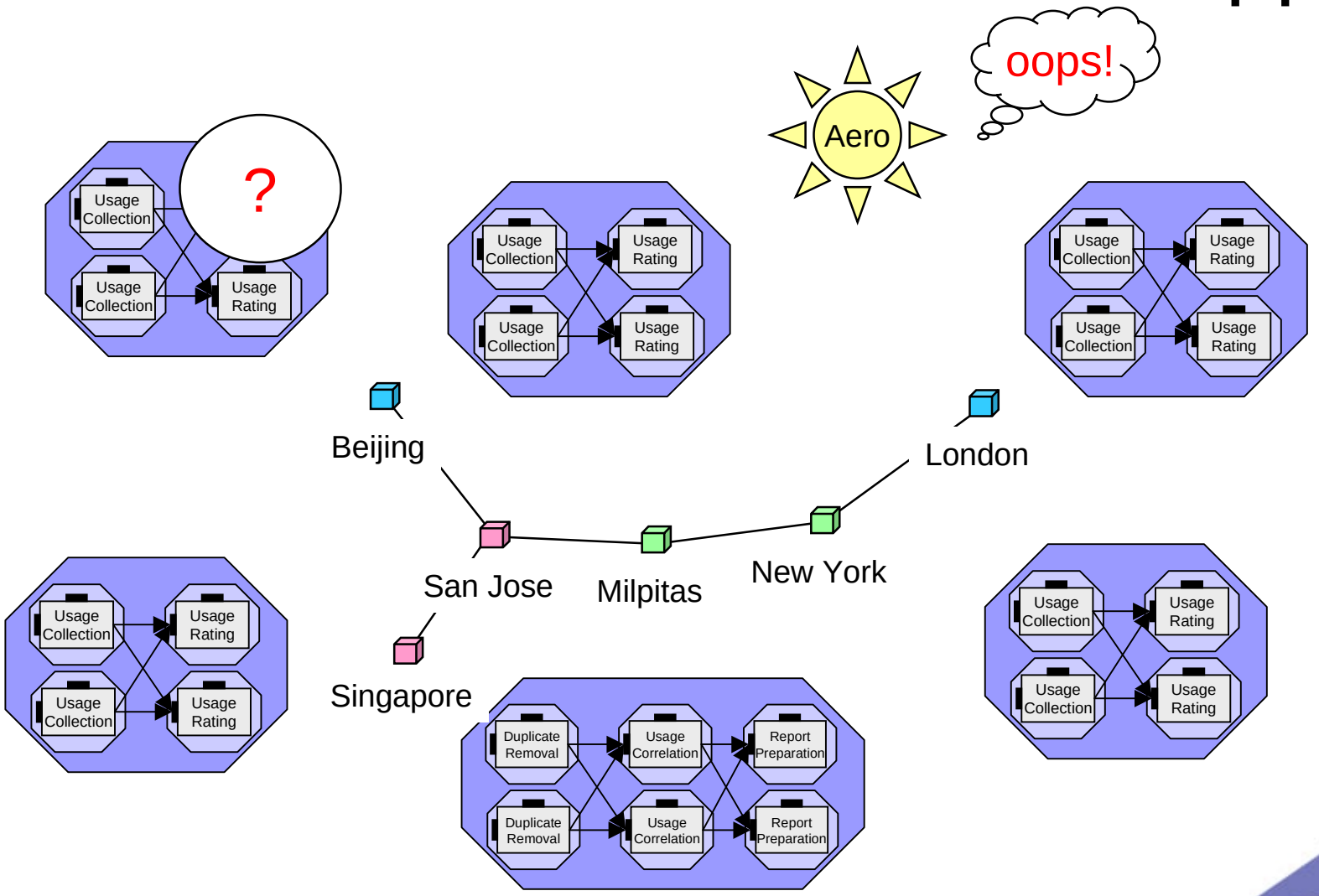
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Component Monitoring



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Failures Happen



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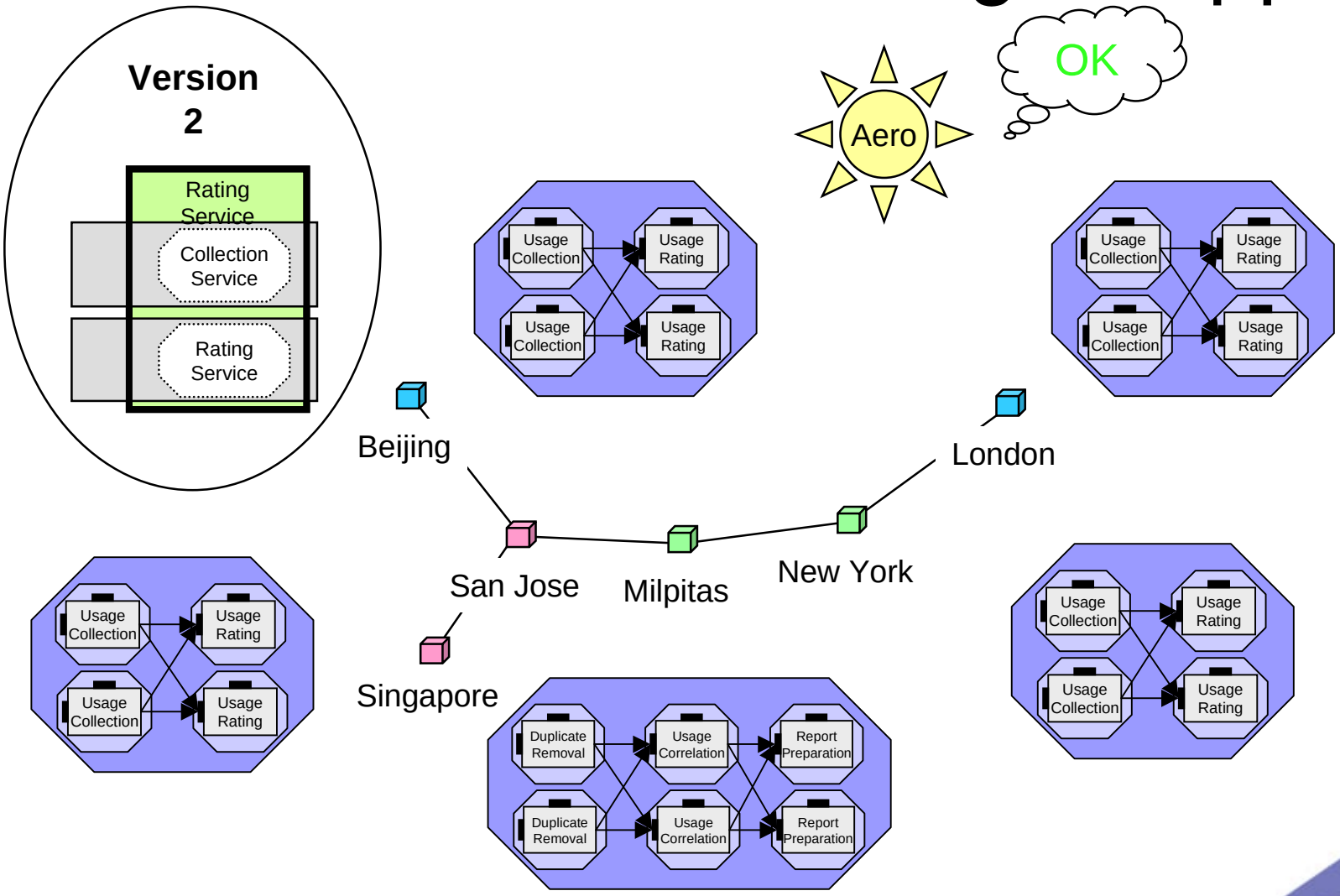
Recover from Them

- Nodes monitor the status of active capsules
- Locators insulate clients from capsule failures
- Redundant components used automatically
- Nodes initiate restart of failed capsules
- Groups use application knowledge to re-introduce restarted components to the rest of the system

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Change Happens



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Evolve Gracefully

- Domain maintains versions of services, packages, components and interfaces
- Determine extent of necessary changes
  - interfaces have major impact
- Replace impacted running components with new versions & reintroduce with minimal impact to system operation
  - constructive failures

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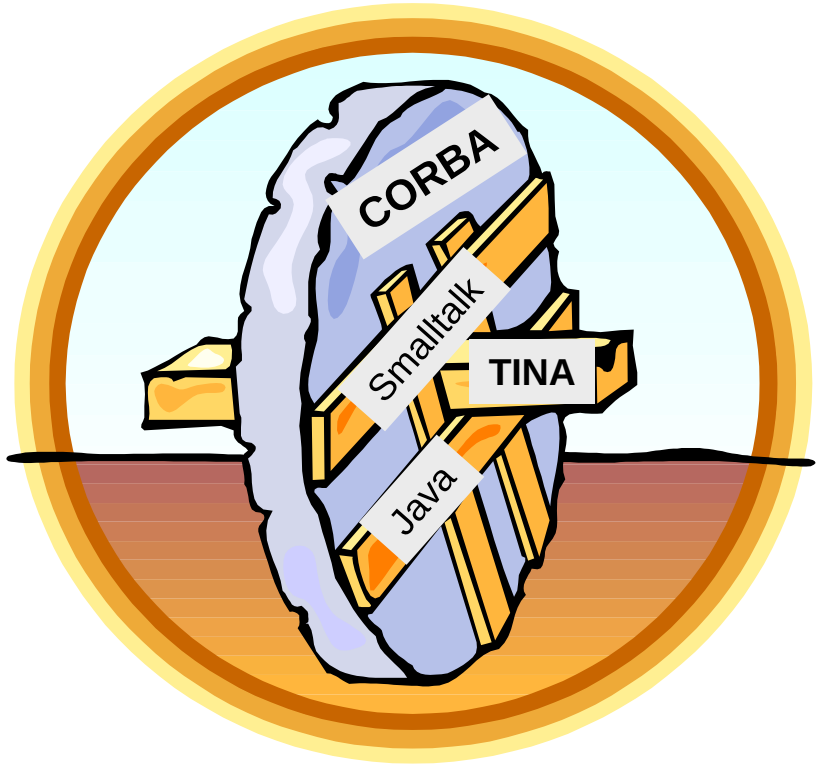


Where do we go from here?

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It Works, but Where Do We Go From Here?



The future is always constrained by the past

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Be More Like the Sun Vision?

- Migrate all Smalltalk into Java
- Migrate some communication to RMI
- Migrate groups to Jini for introduction
- Migrate components to EJB
- Buy EJB containers to replace capsules
- Look for a Jiro management solution to weave it all together

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Be More Like the OMG Vision?

- Migrate component definitions to CDL
- Buy CORBA containers to replace capsules
- Map groups onto CORBA Trading
- Look for a unified management solution to weave it all together

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Be More Like the Microsoft Vision?

- Port services to a .NET supported language
- Define all services in WSDL
- Migrate communication to SOAP
- Figure out how DISCO works and migrate
- Look for a unified management solution to weave it all together

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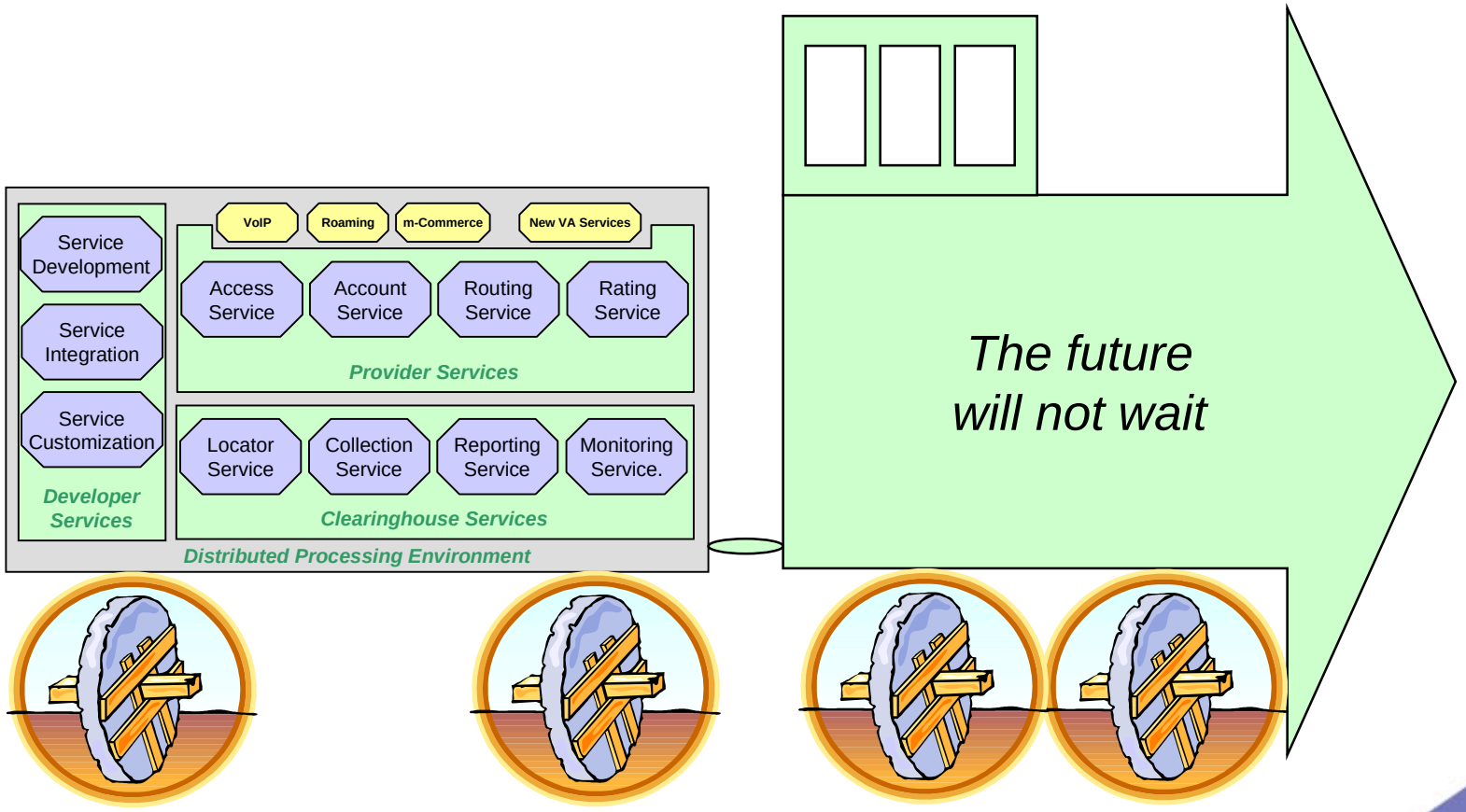


Hum, Being More Like “X” Means

- Migrate everything that’s already working to something new that might work better
- Look for a unified management solution to weave it all together better than what we already have working now
- Good business or good technology?

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Keep on Truckin'



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