# Cloud Infrastructure for Providing Tools as a Service: Architectural Requirements and Potential Solutions

**M. Ali Babar**

**IT University of Copenhagen, Denmark**

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# Overview

- Global Software Engineering (GSE)
- Scenarios of tool support challenges
- Leveraging Cloud Computing for GSE
- Requirements & potential solutions
- MDE & Cloud Computing
- Concluding remarks

# Background Brief

M. Ali Babar

Associate Professor @ ITU

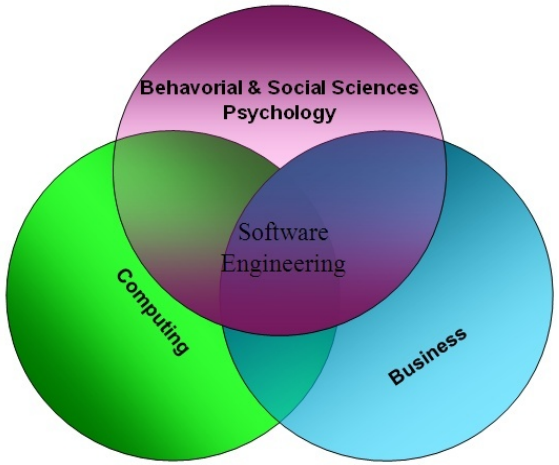
PhD in CSE, University of New South Wales

Work History:

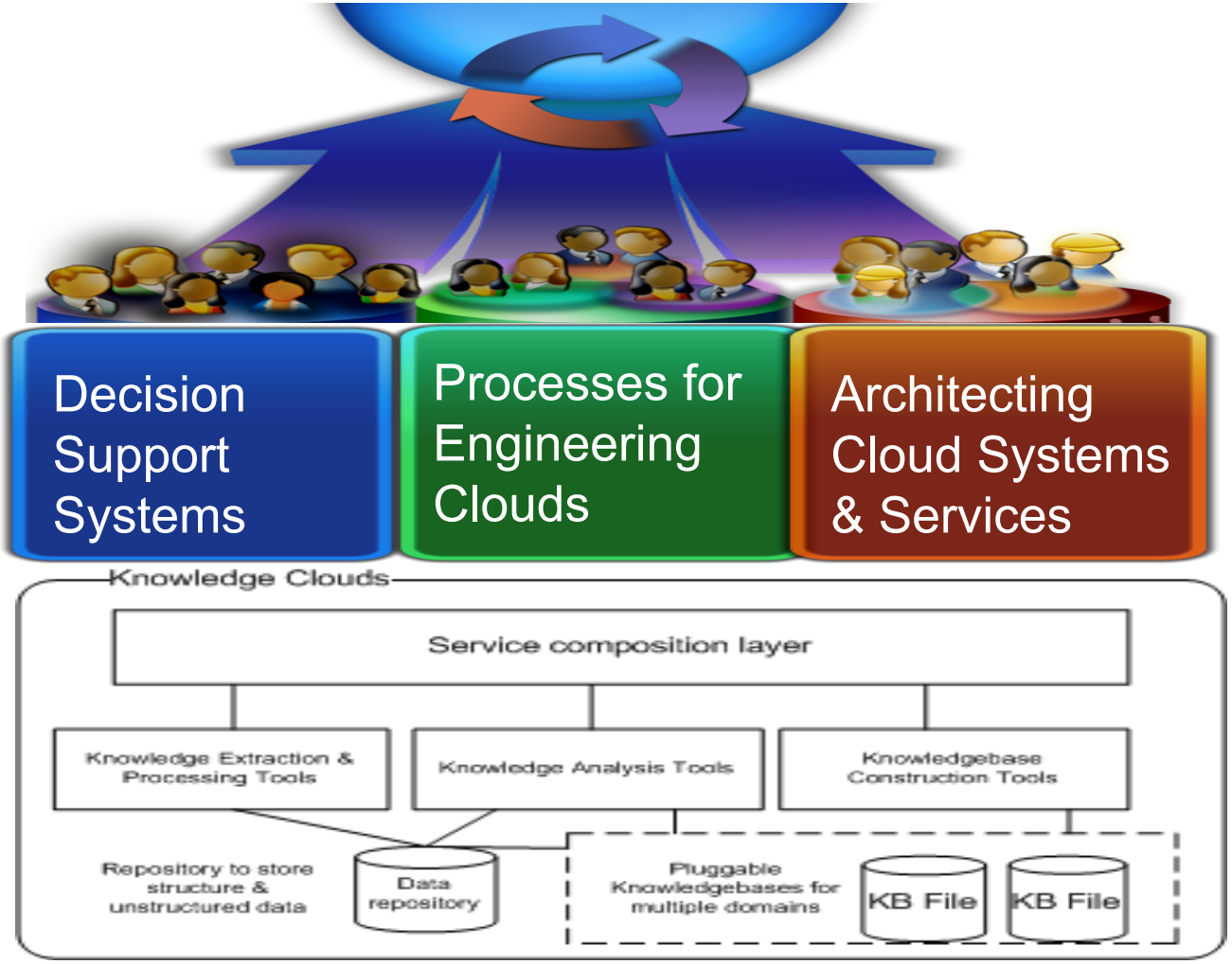
- ITU, CPH: Dec. 2009 …
- Lero, Ireland: 2007 – 2009
- NICTA, Australia: 2003 - 2007
- JRCASE, Macquarie University: 2001 – 2003
- Various industrial roles in IT: Prior to 2001

Research in software architecture, Service Orientation, Cloud Computing, and Software Development Paradigm

http://malibabar.wordpress.com

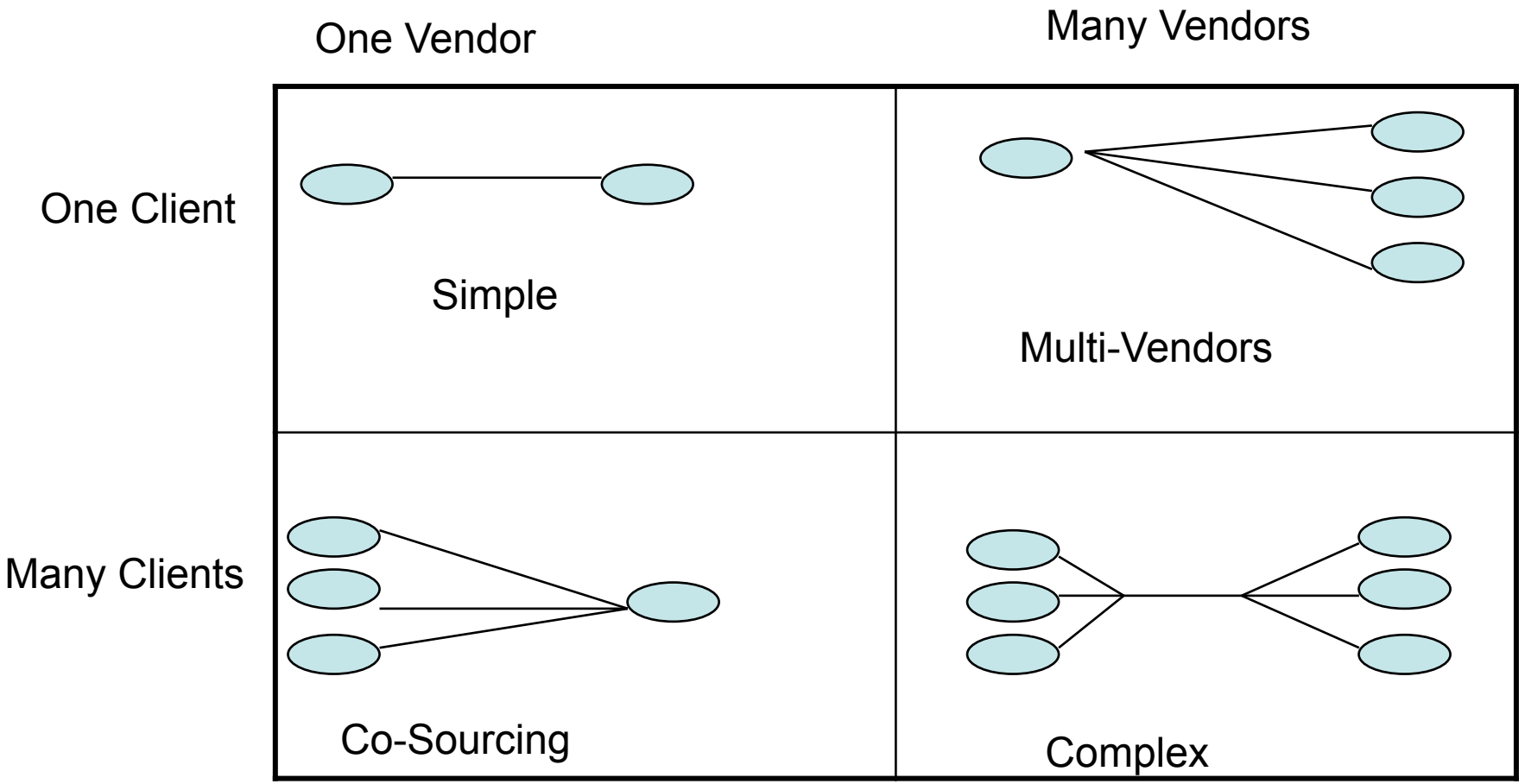


# Cloud Computing Research Threads



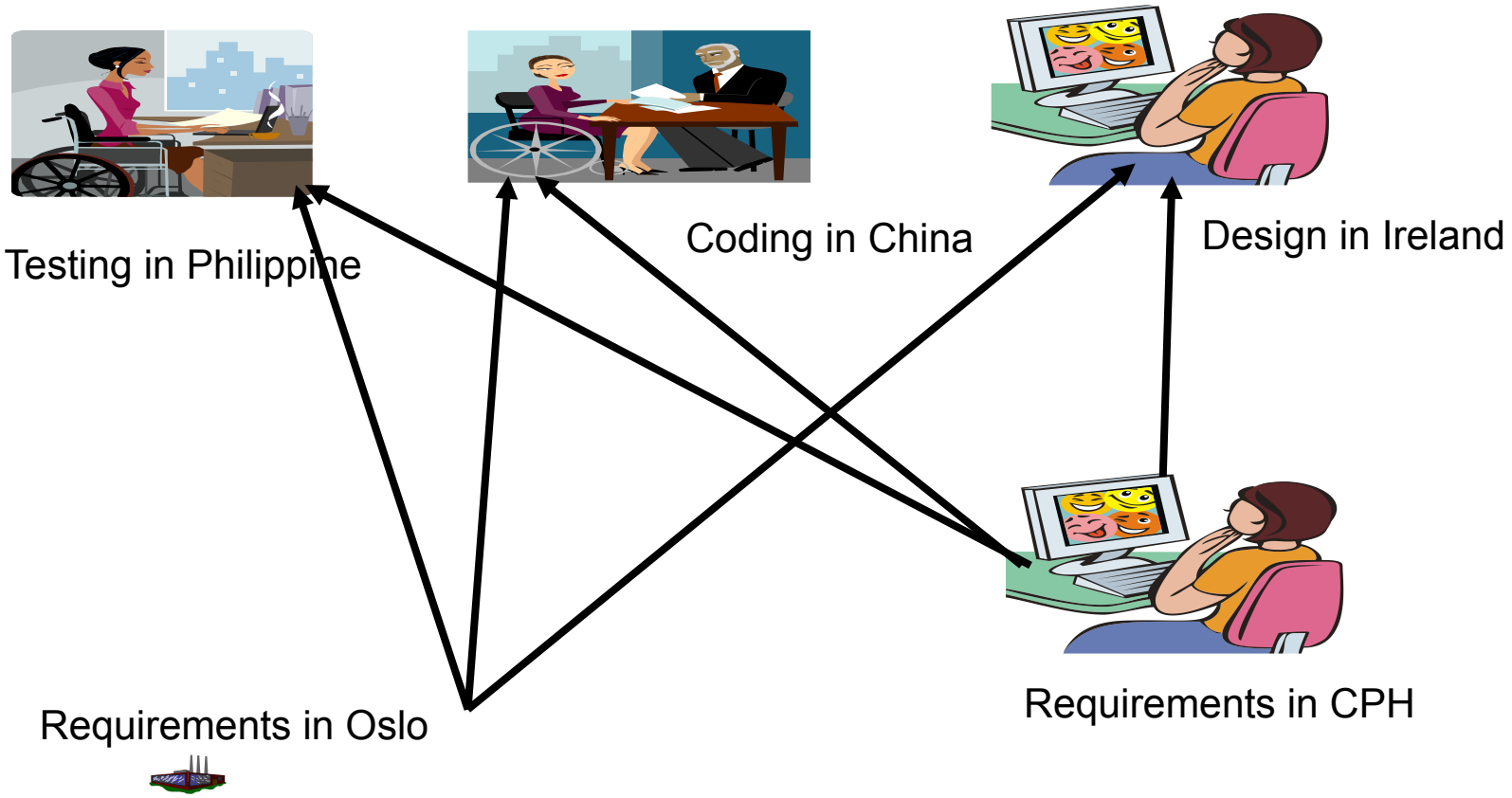
# Many Meanings & Forms of GSE

# Types of GSE Arrangements



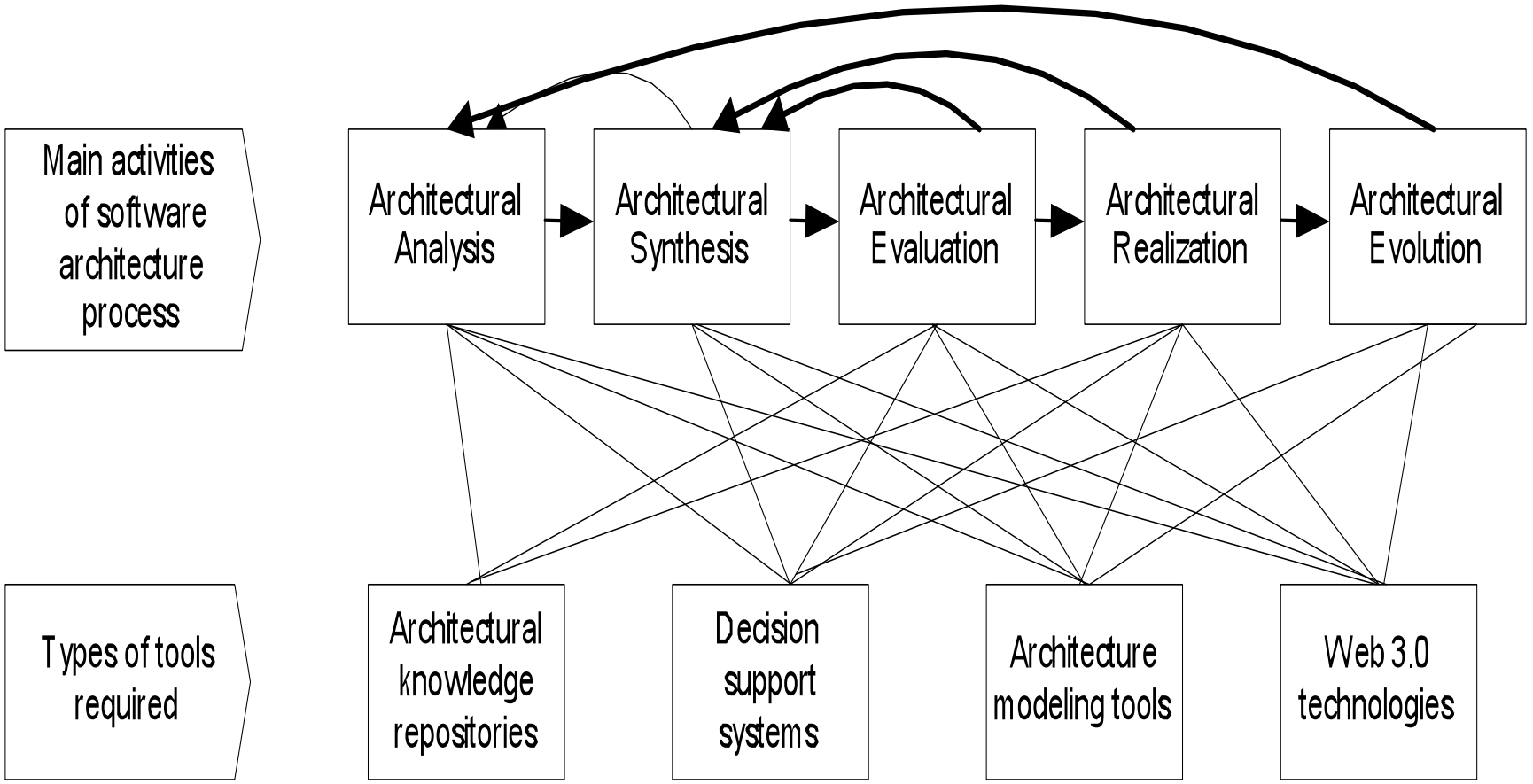

Source: Gallivan and Oh, 1999

# Inter- & Intra-Organizational SE Processes

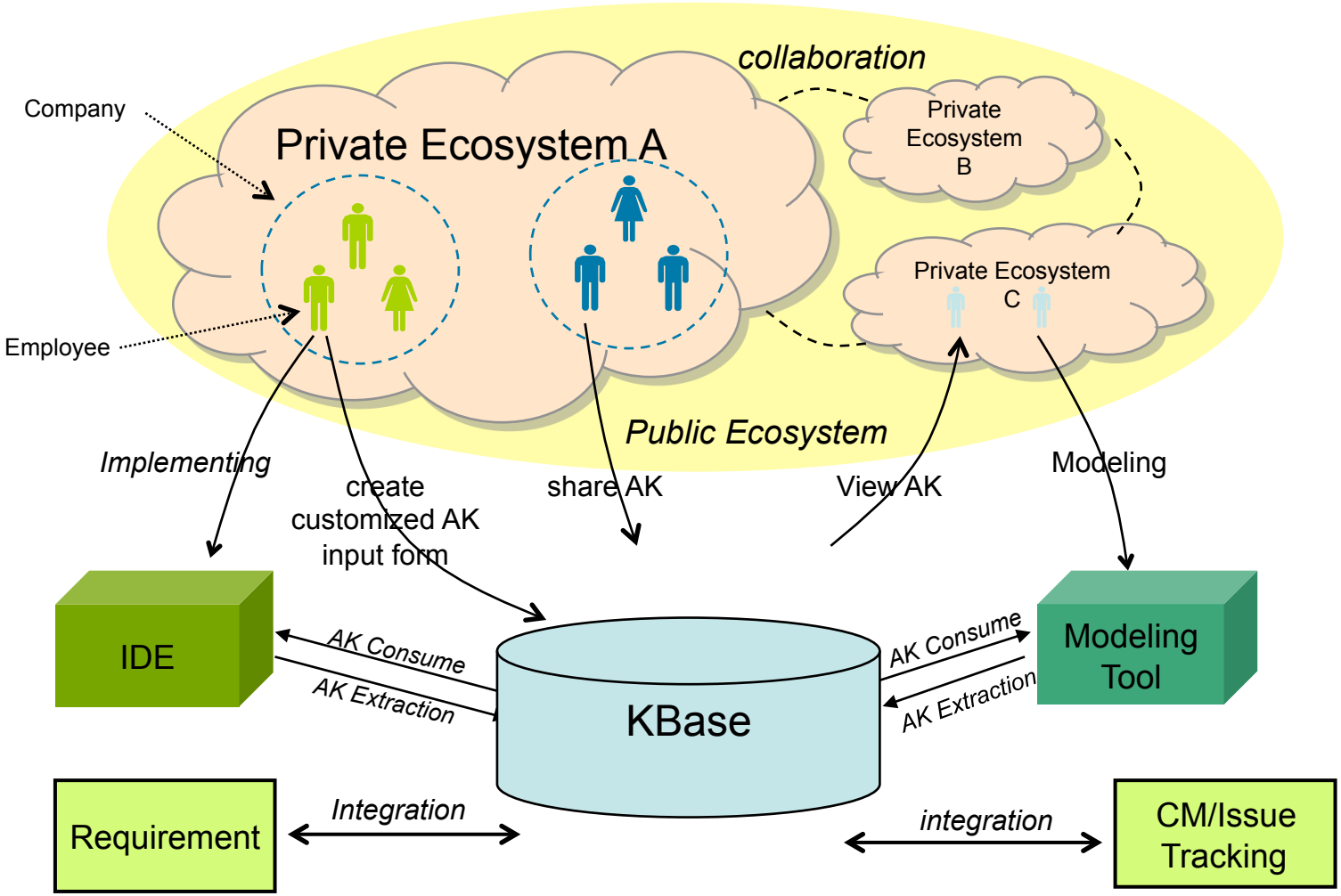


# Scenarios of tool support challenges

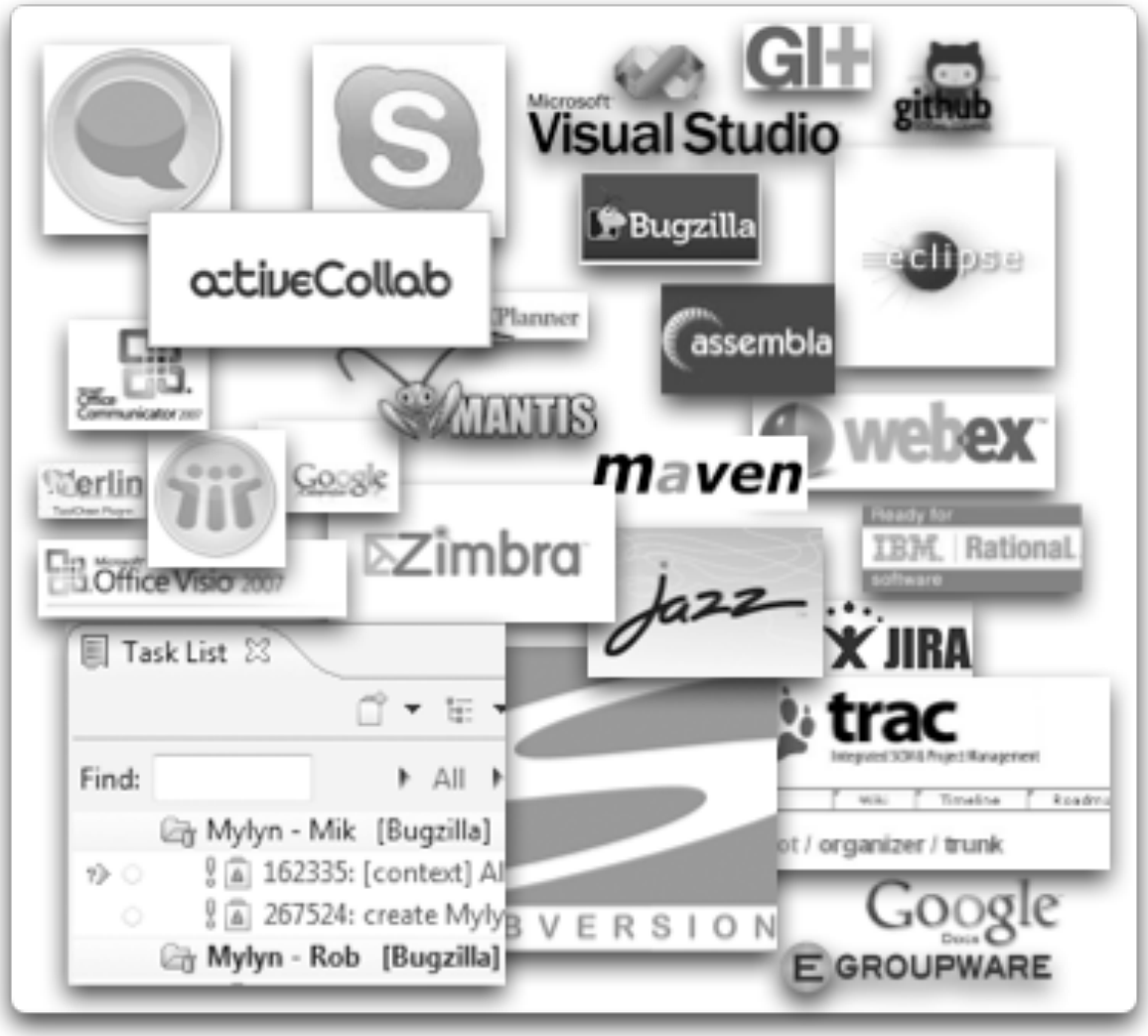
# Tools for Distributed Architecting Process



# Tools for Knowledge Ecosystems

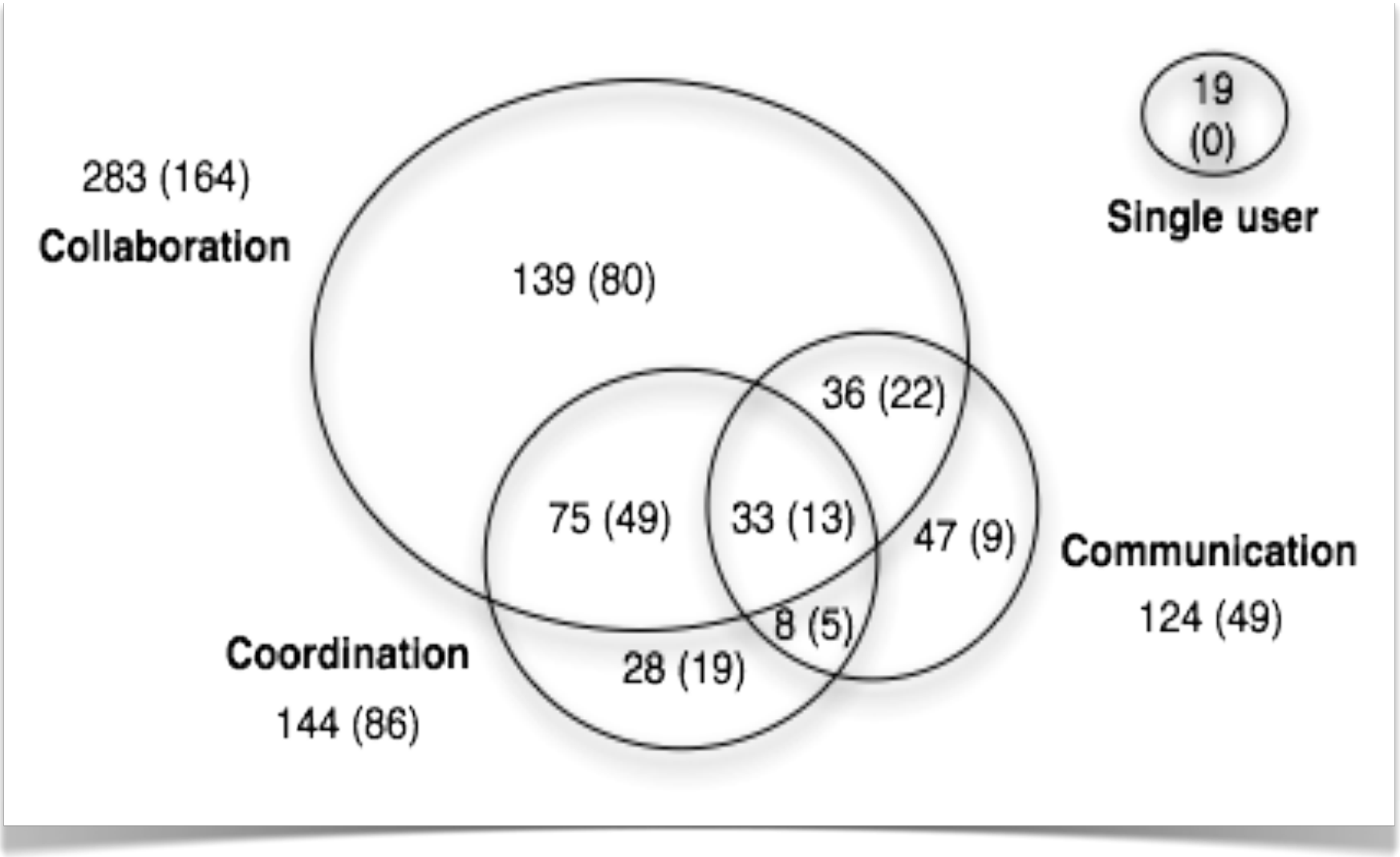


# Tool Support for GSE

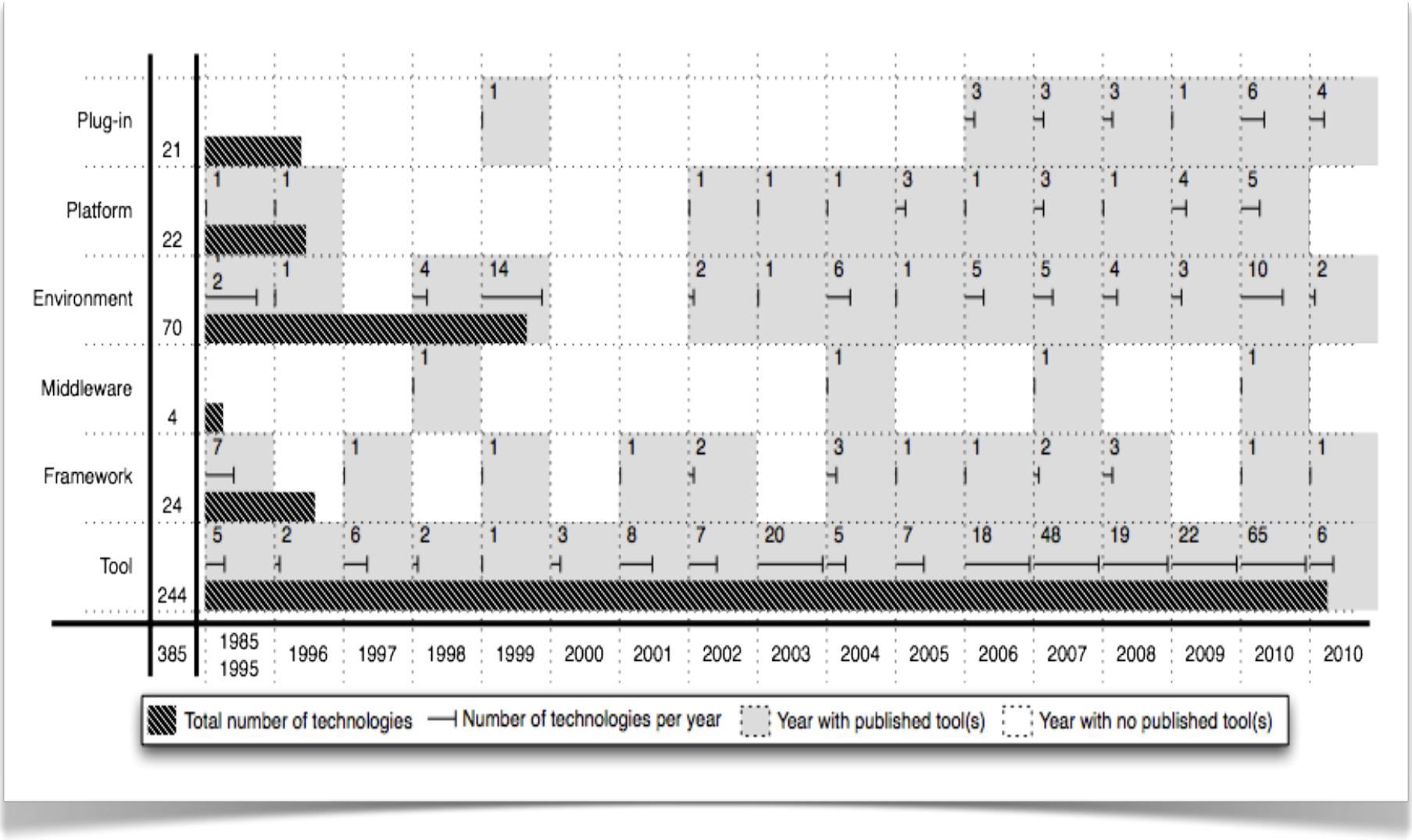



Integration provided at the application level (C/S)

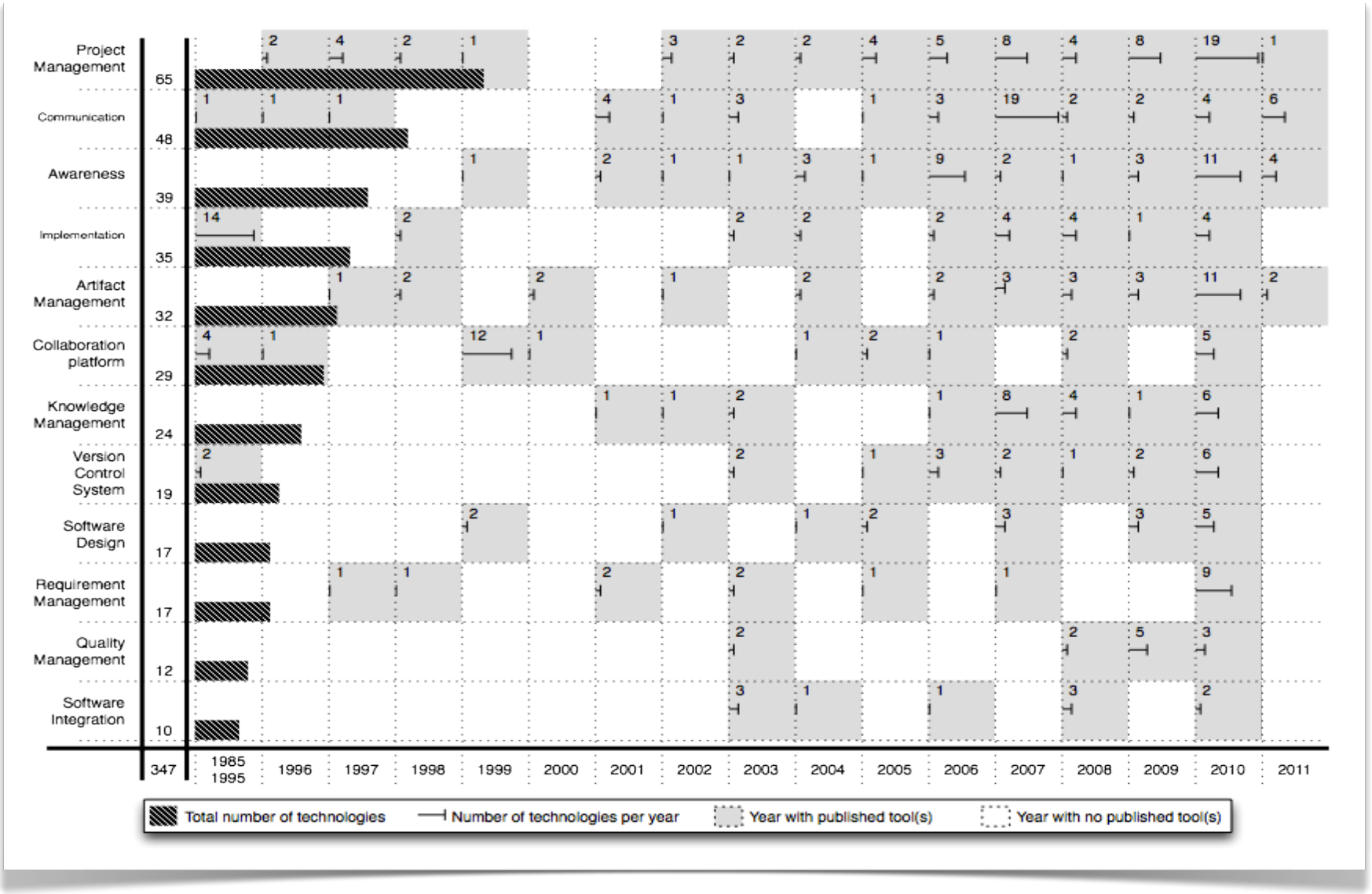
# Tools Supporting 3C Model



# Technological Classification



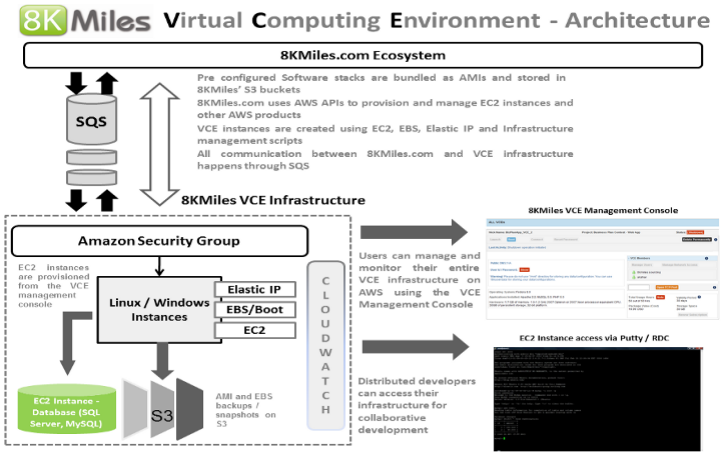
# Process-Centric Classification



# Leveraging Cloud Computing for GSE

# Why Cloud Computing Matters for GSE?

- Testing as a Service (TaaS)
  - Stress testing with cloud-based infrastructure
  - Enabling testing of application for sensitive data by offshore testers
- Collaborative environments in Clouds
  - Just-in-Time (JIT) tool composition
  - Processes,  tools, & context aligned




Source: http://aws.amazon.com/solutions/case-studies/8kmiles/

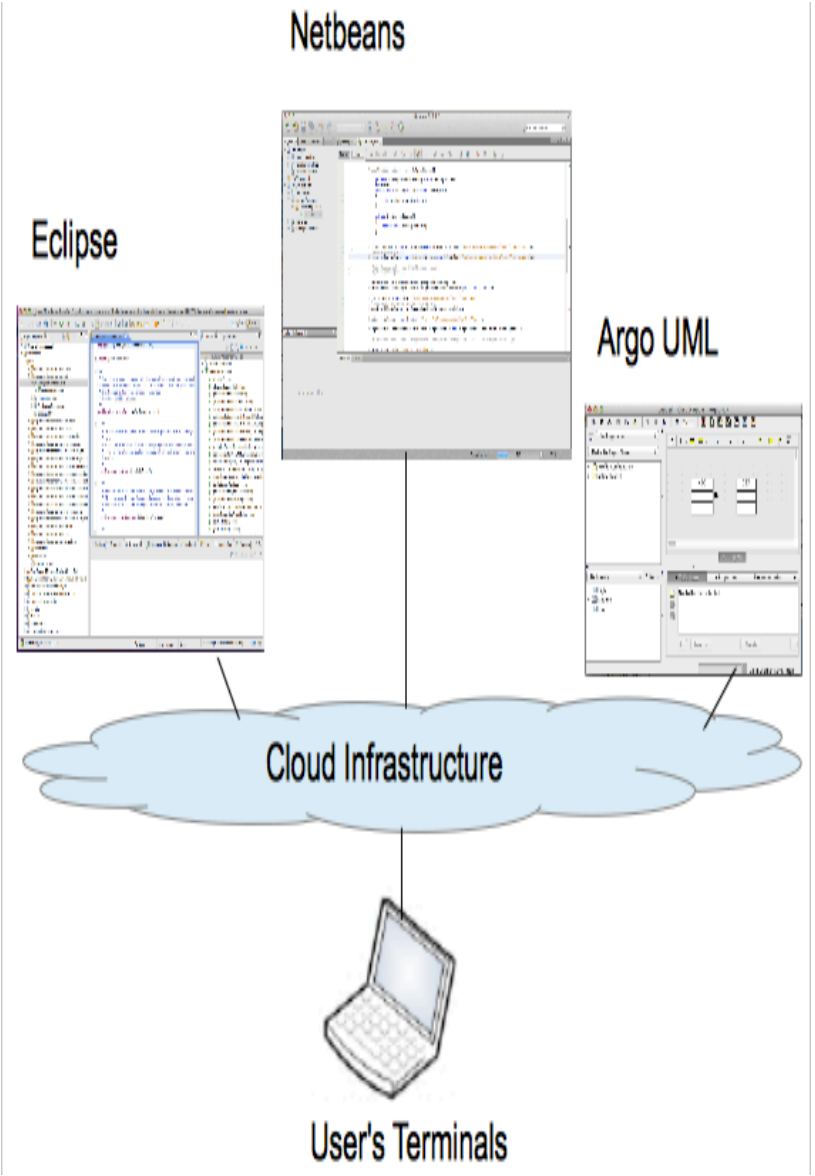
# NexGen Infrastructure for GSE

- Context
  - Providing supportive technologies to GSE teams
- Challenges
  - Dozens of different tools required
  - Some commercial tools (IBM SameTime and MS Communicator) available but across vendor integration is problematic and the tools are expensive
  - No Just In Time (JIT) composition and use of services
  - Misalignment between tools, processes, and culture
- Proposed solution
  - Cloud-Based Infrastructure for supporting GSE through Tool as a Service (TaaS)

# Advantages of TaaS for GSE



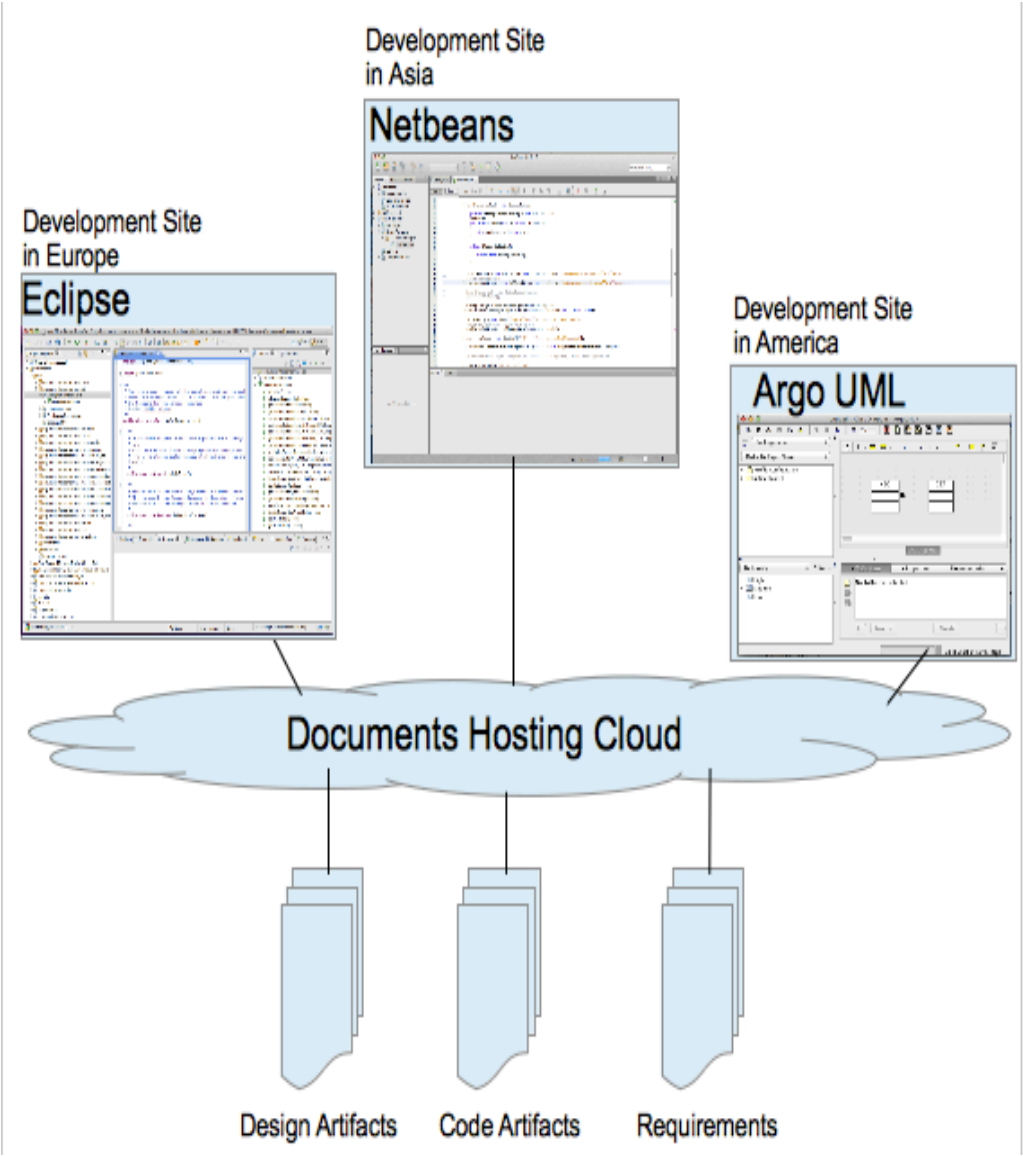
- On demand tools acquisition & access to a wide range of tools
- Processes and tools alignment – acquiring tools for process requirements of each project



# Advantages of TaaS for GSE

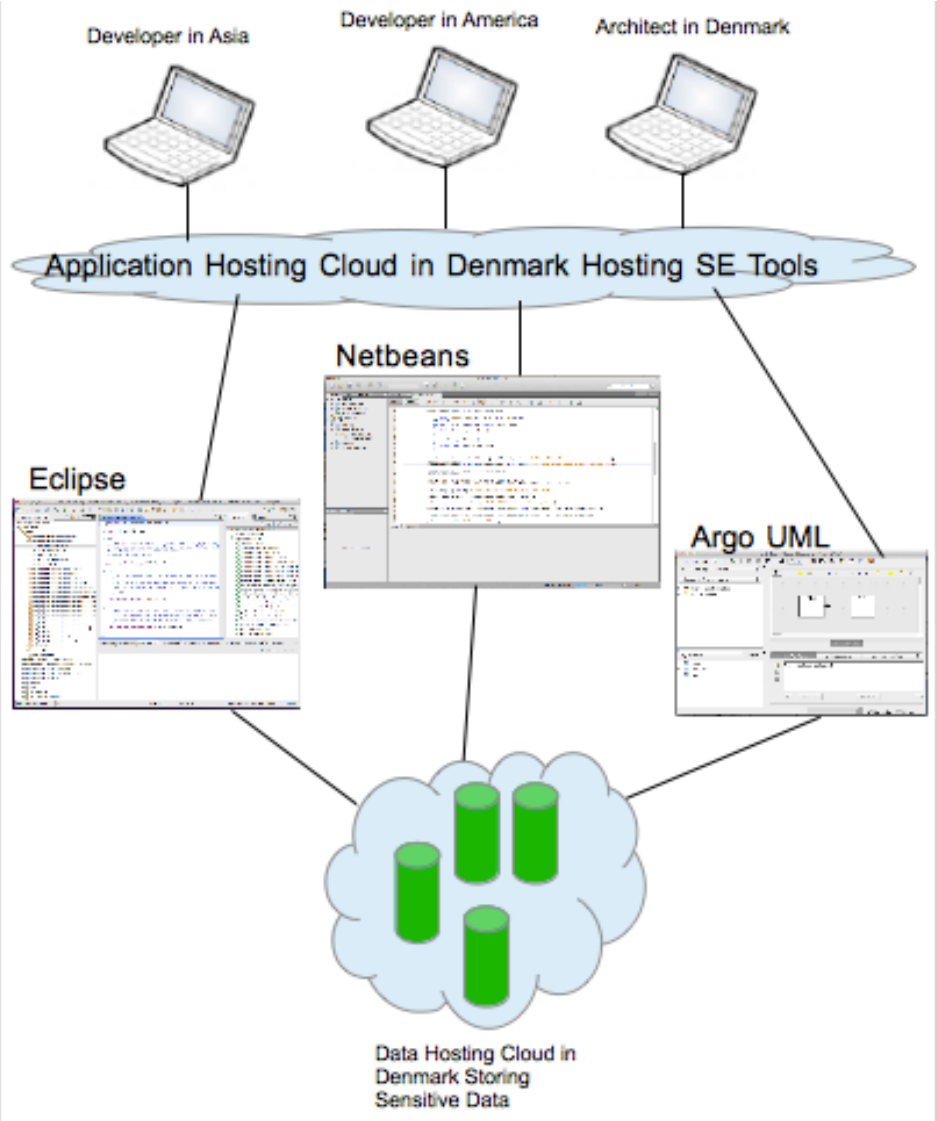


- Artifacts' traceability across multiple sites
- Implicit support for real -time awareness and collaboration

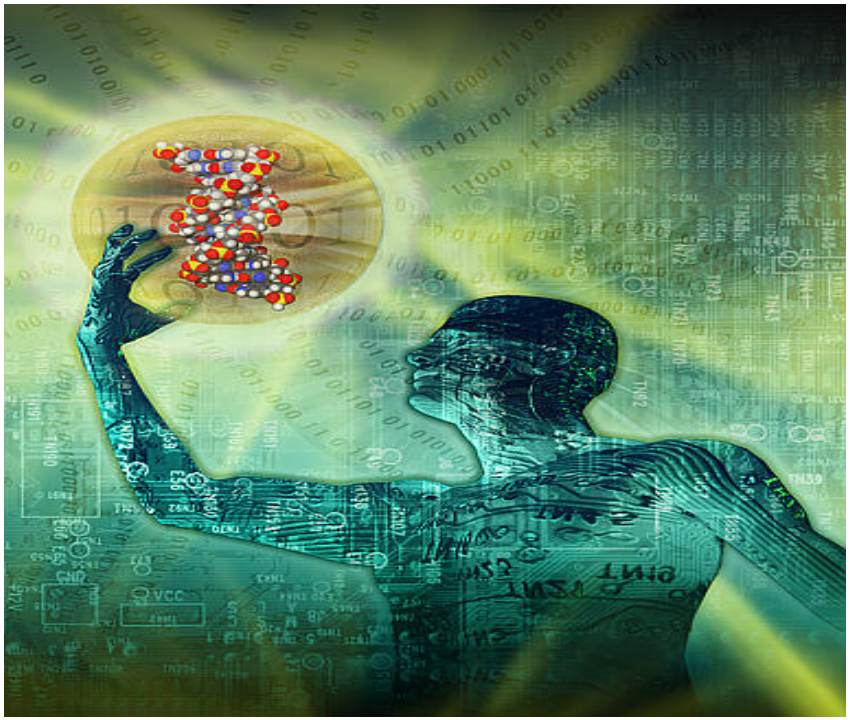


# Advantages of TaaS for GSE 3/3

- Access to sensitive and massive amount of data without data movement
- Easy access to expensive and sensitive technologies



# Requirements & Potential Solutions!!!



# Requirements & Solutions



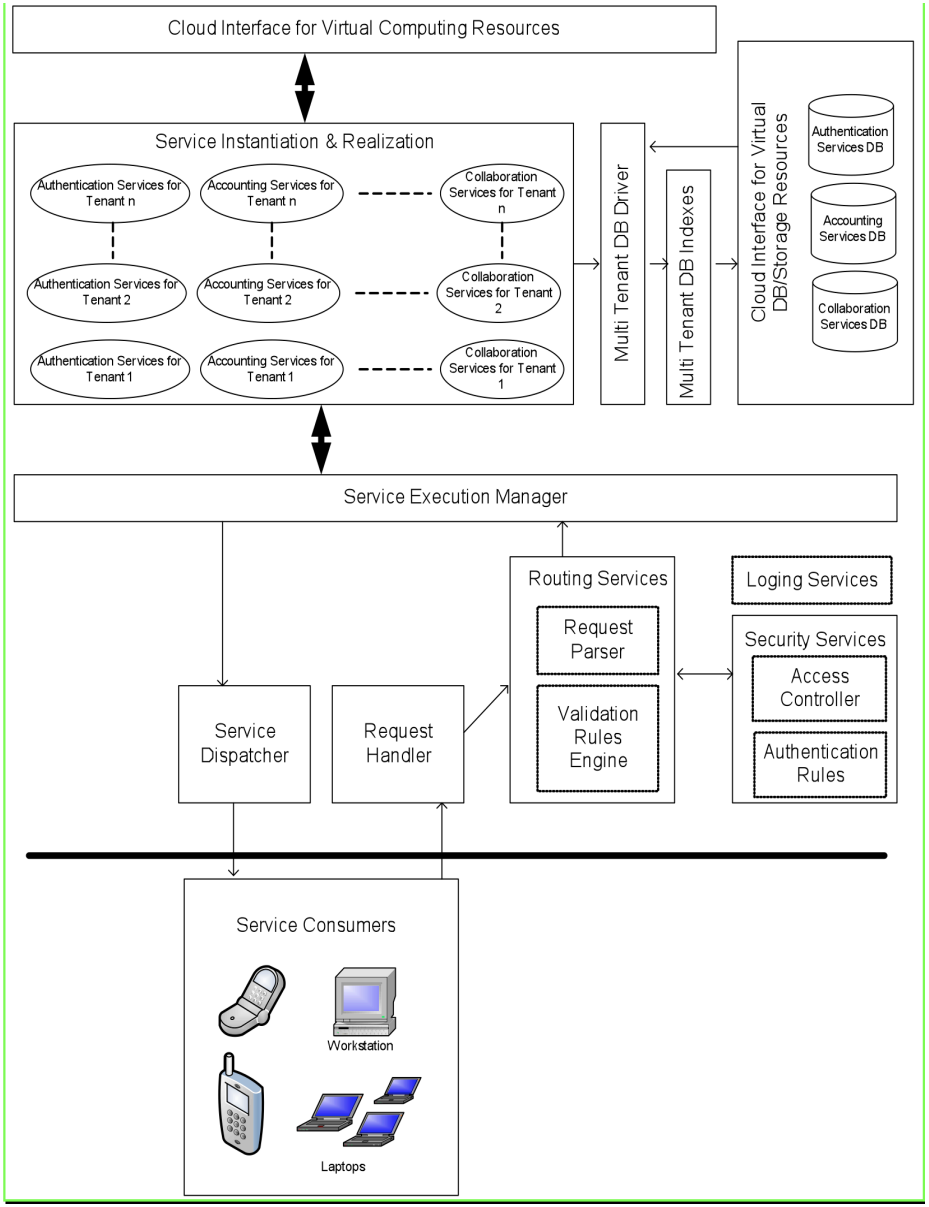
- Support for multiple organizations & teams
  - Multi-tenancy for providing isolation between multiple services
  - Privacy and security handling services
- Tools  versioning and bundling
  - Version management for maintaining partitioning between different versions of tools & combining them as a tool suite
- Integration with commercially available tools
  - Platform neutral APIs and compatible data structure
- Tools working with private data and artefacts
  - Workflow like distributable data processing services

# Requirements & Solutions 2/2

- Support for multiple types of persistence methods
  - Design & exploit a multi-tenant database driver
- Accessibility from multiple types of devices
  - Dynamic distribution of processing load on devices & clouds
  - Provide hooks for implementing or interacting with services for defining & selecting optimal configuration strategy for tools
  - Transform responses to formats recognizable by client devices
- Compliance with Service Level Agreement (SLA) – QoS
  - Specify machine readable & dynamically changeable SLAs
  - Continuous monitoring & dynamic execution of services according to SLA specification (e.g., scalability rules & elasticity algorithms)

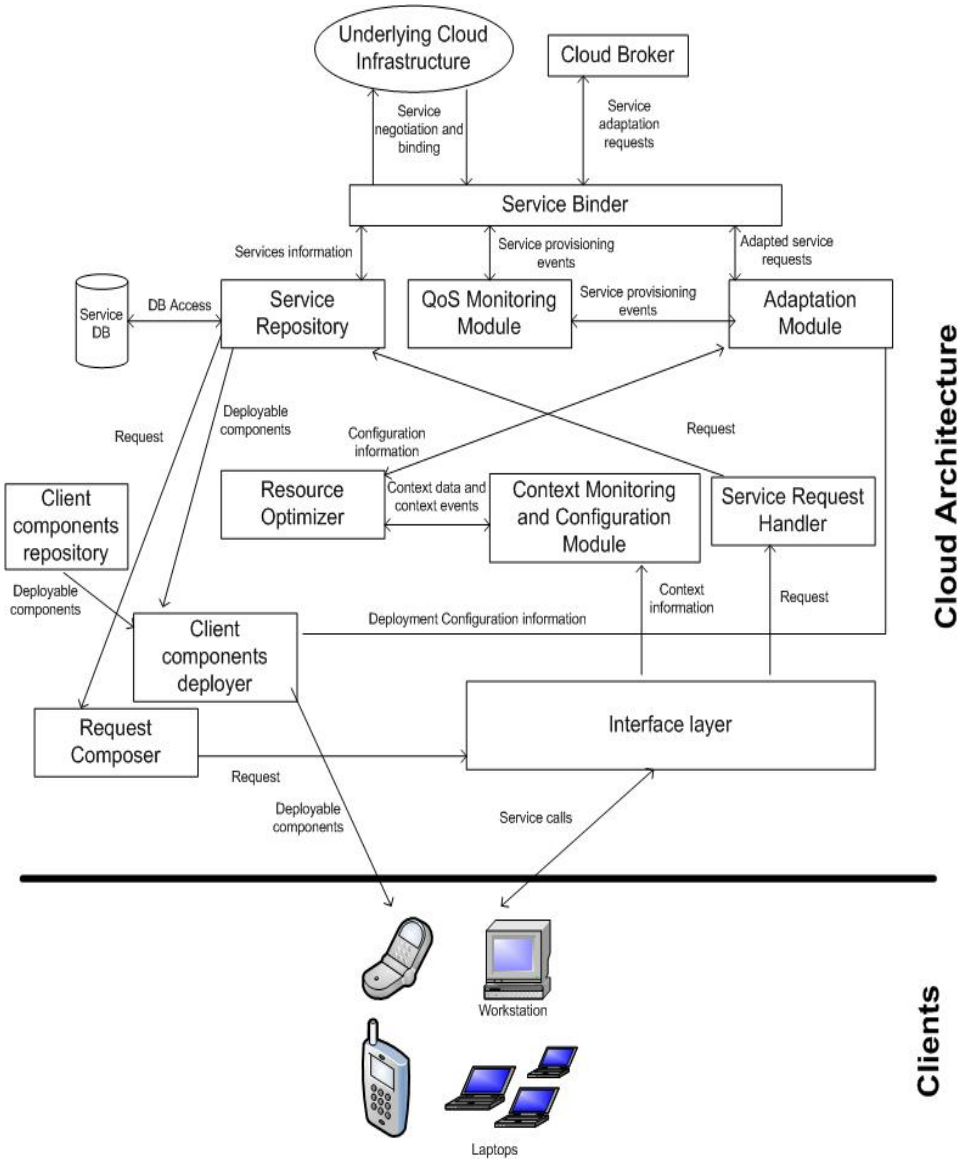
# Supporting Multi-Tenancy

- Handling & serving requests from a single server
- Parsing & validating requests for services
- Access control & authentication rules
- Services management
- Multi-tenant DB driver & Indexes

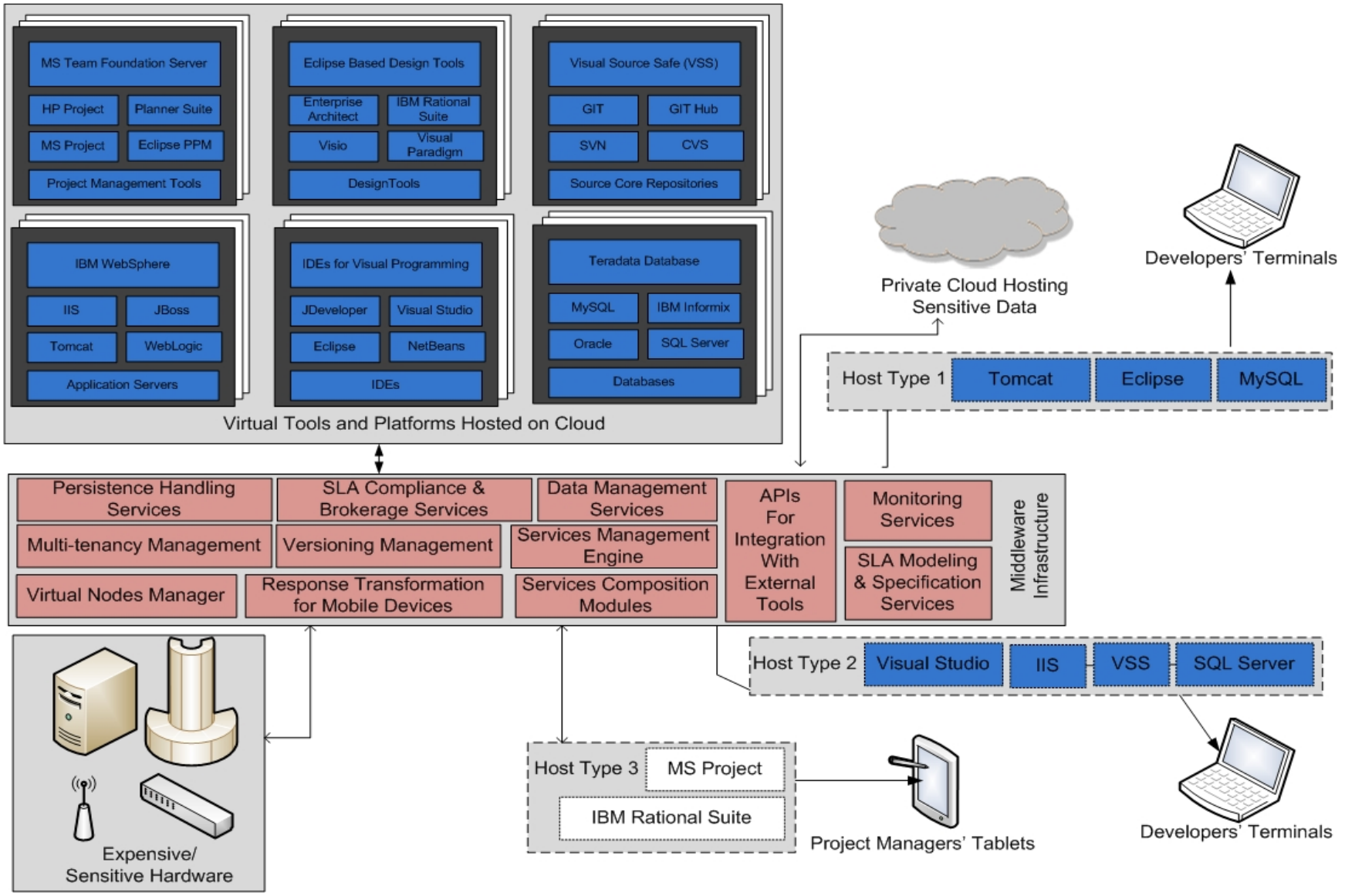


# Supporting Multiple Types of Devices

- Platform neutral interfaces
- Context monitoring & configuration
- Resource optimization
- Self managed clients components
- Response composition



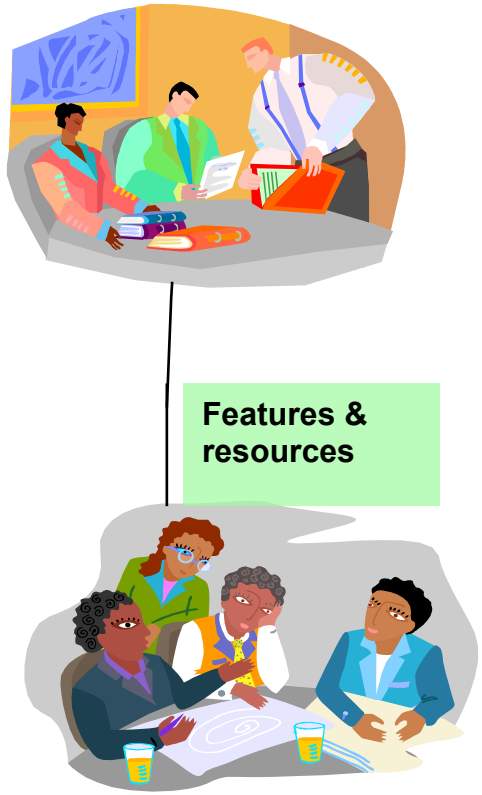
# A Reference Architecture



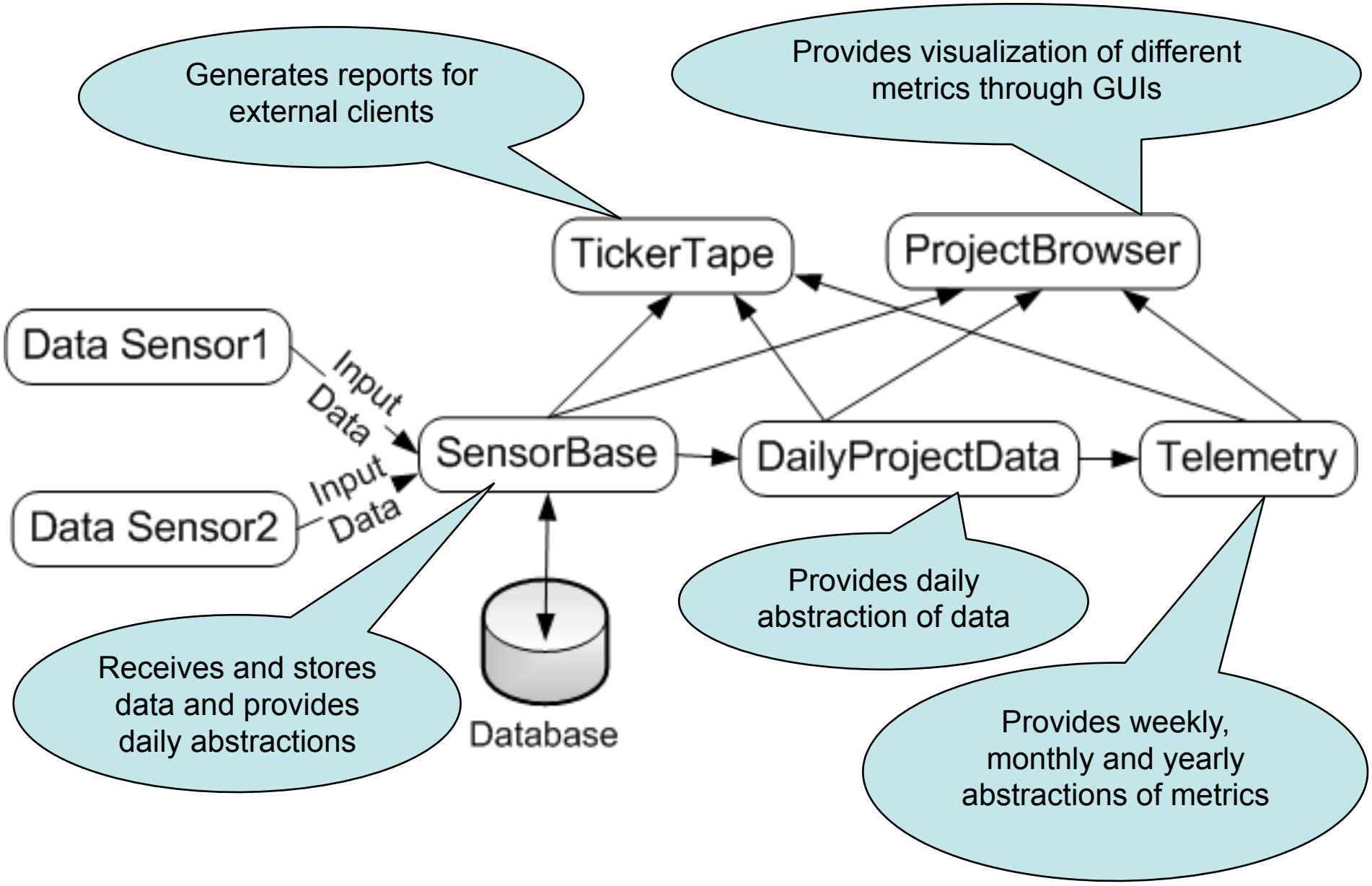
# MDE & Cloud Computing

# Migrating Tools to Cloud Computing

- Methods, Processes, and Tools are required
- Supporting migration by providing process framework and guidelines
- A case of migrating a software metrics system - Hackystat
  - Supporting large number of organizations for process and product metrics in GSE
  - Requires elastic computing and storage resources
  - SaaS on IaaS (Amazon) or SaaS on PaaS (Goolge)



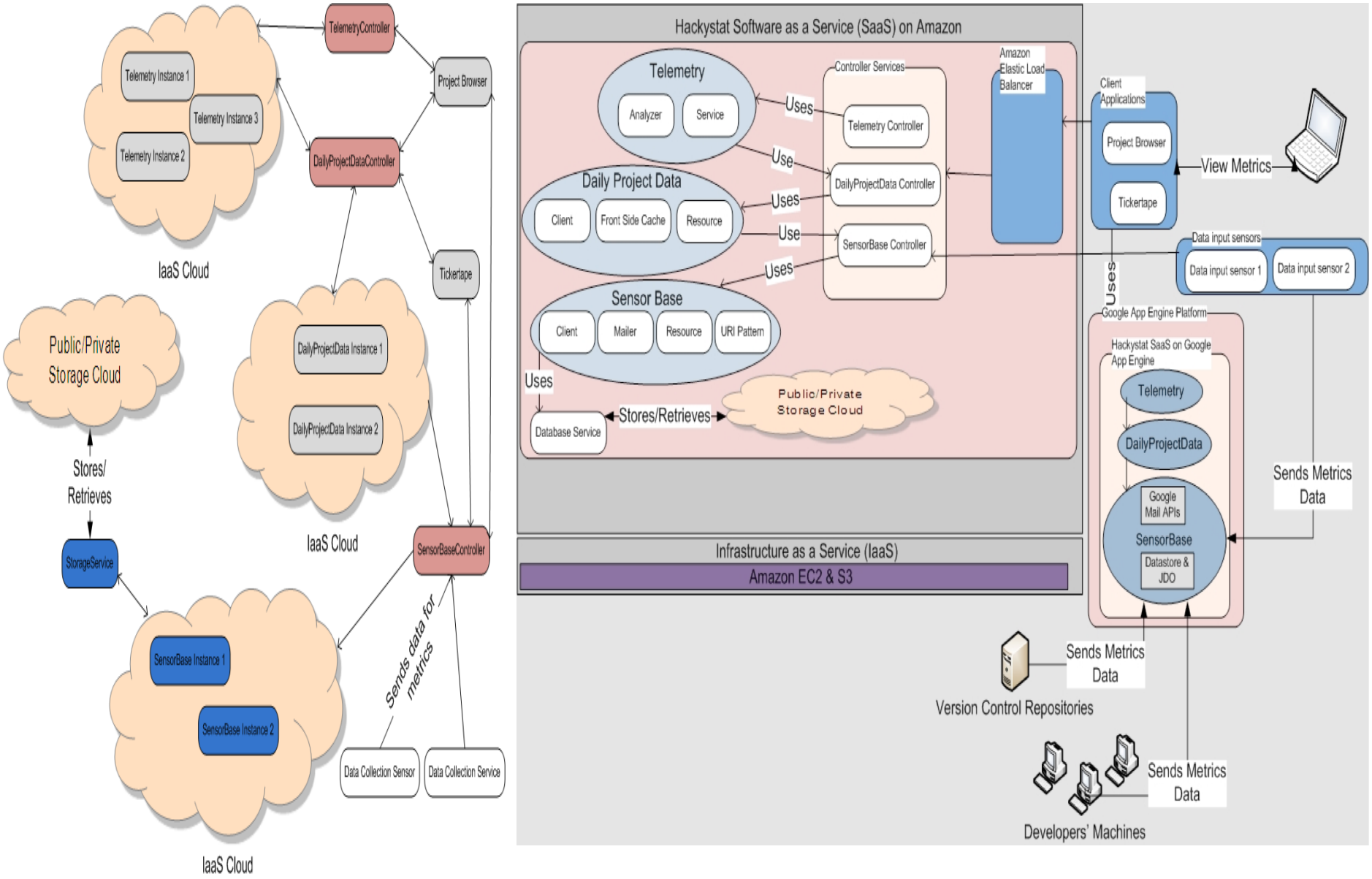
# Architectural View of HackyStat



# Quality Attributes & Architectural Decisions

| Quality Attributes | Architectural Decisions | |
|---|---|---|
| | ***Amazon EC2 & S3*** | ***Google App Engine*** |
| Scalability | Replication of system services to meet performance requirments. | No action required. Scalability is handled by platform. |
| | Separation of database layer into a new service that utilizes platform specific persistency features. | Refactoring of persistency components to make it compatible with Google Datastore persistence. |
| Portability | A wrapper layer is added to ensure platform independence.<br>A separate database layer to provide seamless transfer of database layer. | Portability to other platforms is not possible. |
| Compatibility | System features are exposed through origonal REST API.<br>A wrapper layer is added to provide abstraction to services cluster and their deployment configuration. | System features are exposed through origonal REST API. |
| Reliability & Autonomous Scalability | Façade/Waper layer to provide abstraction.<br>Amazon's Elastic Load Balancer ensures autonomous scalability. | Ensured by platform. |
| Efficient & effective deployments | Amazon Elastic Load Balancer ensures auto scaling as well as efficient and cost effective deployment configuration. | Deployment of application components on cloud is managed by platform. |

# Architectural Views of Hackystat in Cloud



# Key Observations for Research 1/2

- Heavy reliance on cloud infrastructure
  - SaaS on PaaS or IaaS are tightly coupled with the APIs provided by a service provider
  - Huge efforts required for porting applications
- Vendor dependent technology enhancements
  - Make it difficult to deploy and evolve a complex system in public clouds
- Lack of tooling support
  - Existing tools only cover software specific details and do not consider the underlying virtual environment

# Key Observations for Research 2/2

- Evaluation of quality attributes
  - Supporting implementation level investigation of static quality attributes e.g., complexity
  - Modeling & testing unknown users and infrastructures for scalability, accountability…..
  - Modeling & reasoning fine-grained control over privacy and security
- Testing
  - Change in the infrastructure of PaaS/SaaS platforms necessitate continuous testing

# Concluding Remarks!!!

- Cloud Computing matters – We need to quickly learn how to exploit the promised benefits and address the challenges.
- Cloud computing stimulates new research directions for new and novel ways of developing software & services.
- Tools as a Service (TaaS) has huge potential for SE in general and GSE in particular.
- MDE can play a significant role in migrating legacy to or building new tools for cloud-based infrastructures.

# Acknowledgements


- Several colleagues and PhD students have hugely contributed to the work on GSE
- TaaS work is being performed with Aufeef Chauhan through his PhD research
- Tools review work has been performed with Paolo Tell for his PhD research

# Thank You!

## *Questions*

*M. Ali Babar*

*alibabar.m@gmail.com*
*malibabar.wordpress.com*