ALMA Common Software

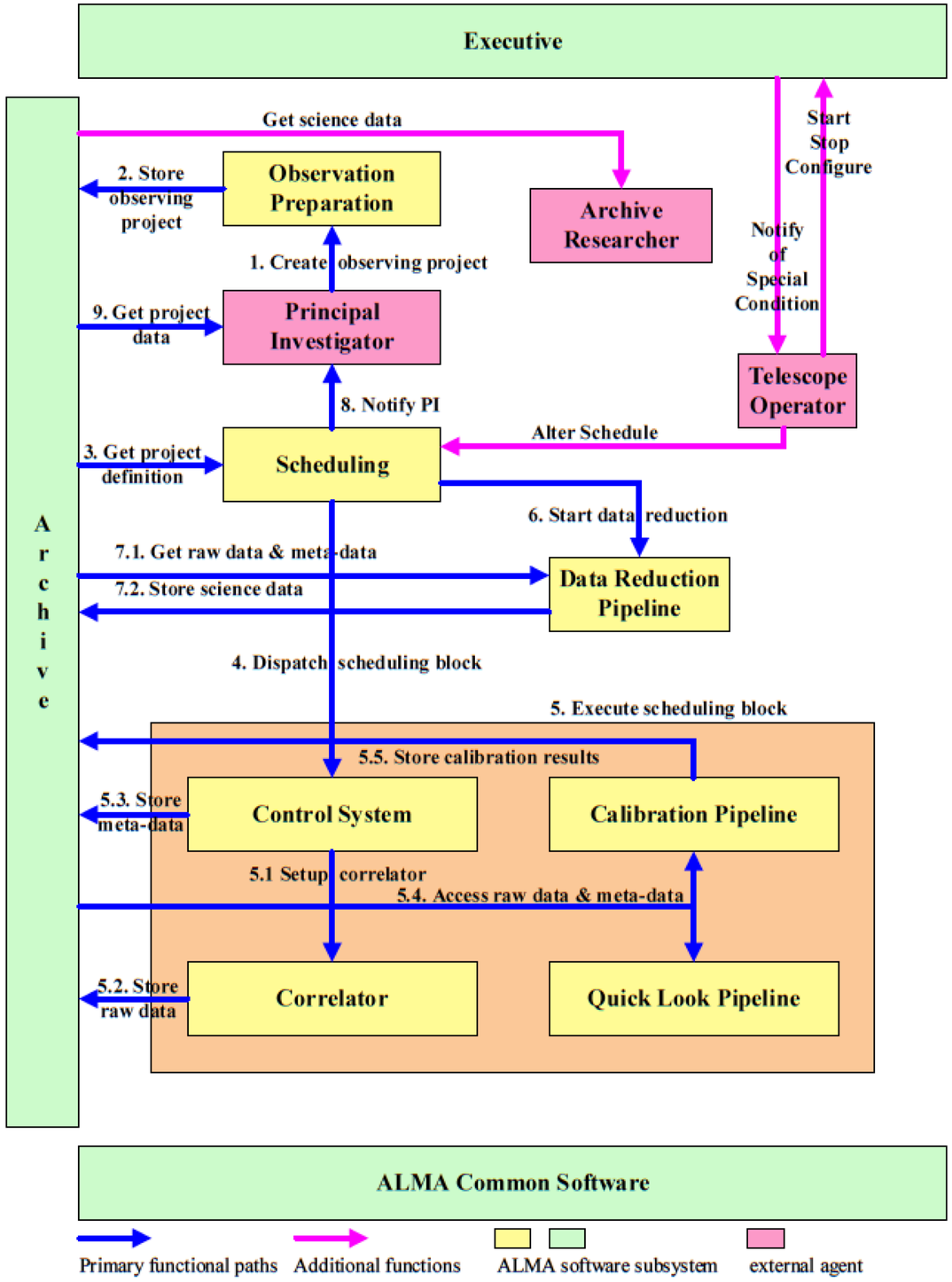
Basic Track

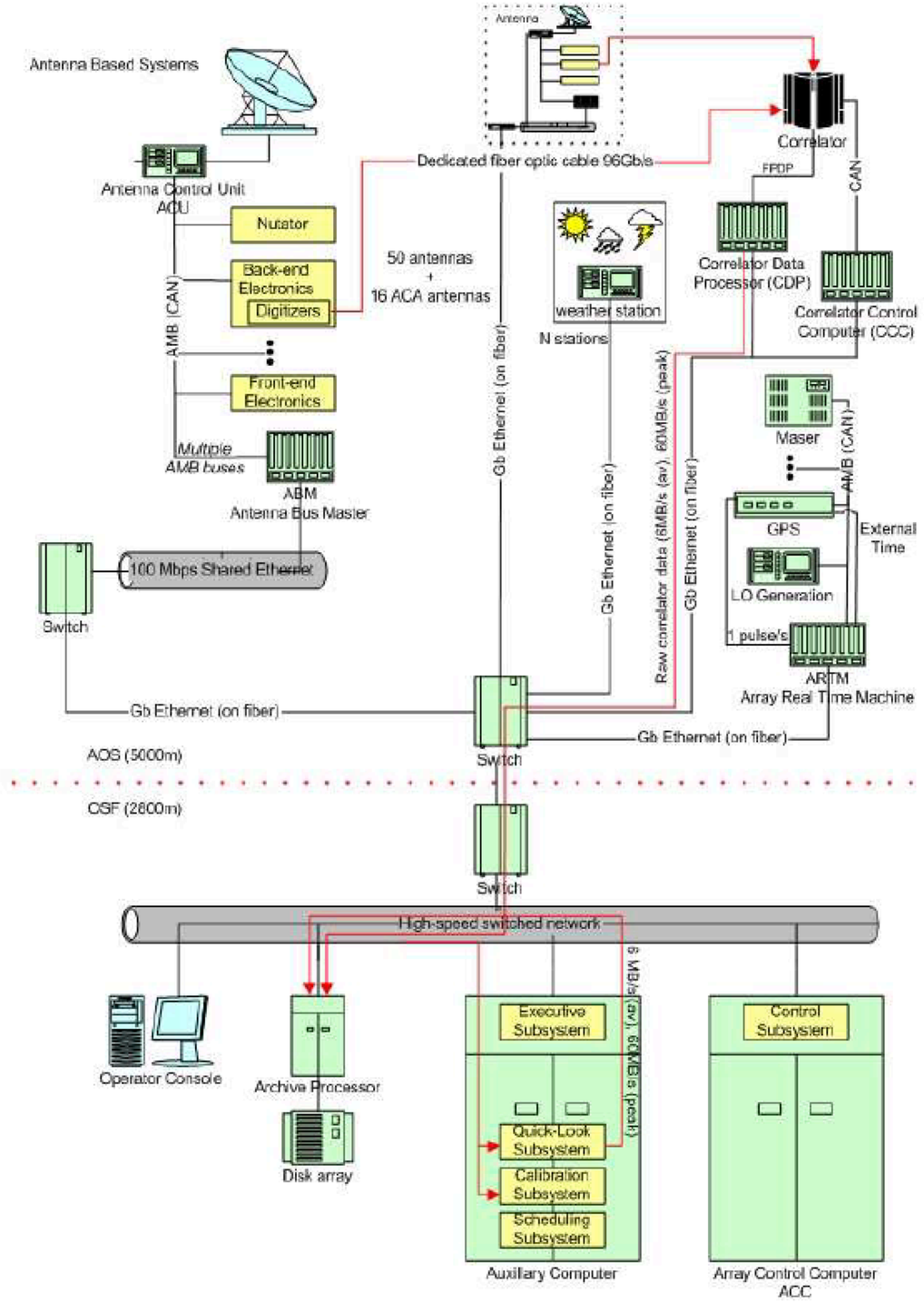
Introduction to the ACS Framework

The Modern Observatory

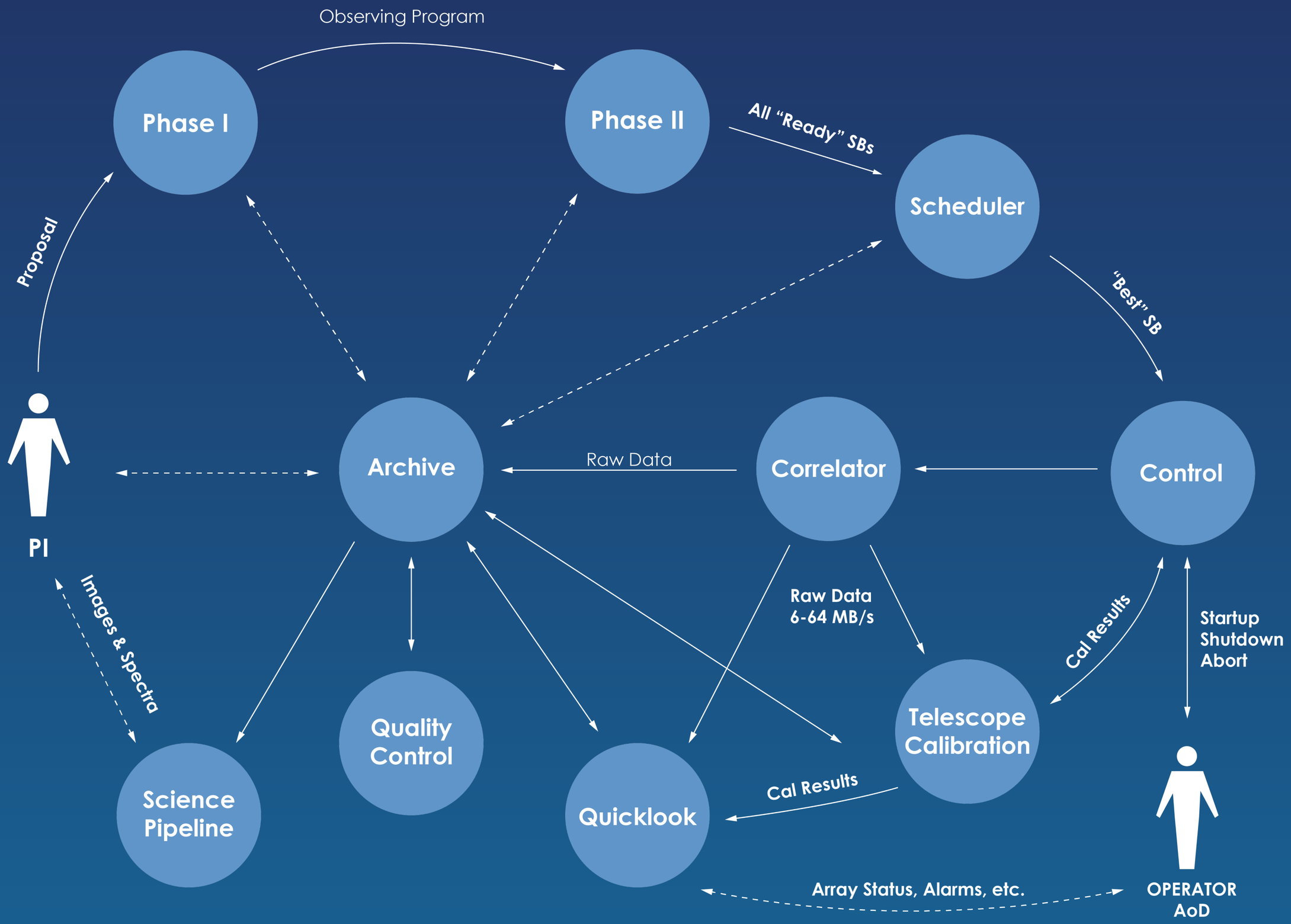
- ✧ Integrated and distributed architecture (end to end data flow)
- ✧ Archive and virtual observatory integration.
- ✧ Feedback systems and distributed control loops.
- ✧ Big projects and small projects: what are the differences?

Example: ALMA Software and Physical Architecture





Example: ALMA Data Flow



Distributed System

Requirement: the observatory is a distributed system.

Servers and clients are distributed on different machines:

- ✧ Possibly in different locations
- ✧ With different purpose and functionality
- ✧ With different requirements on performance and reliability

This leads to a…

Heterogeneous Distributed System

Requirement: the observatory shall be a heterogeneous distributed system.

Servers and clients may use different:

- ✧ Hardware
- ✧ System software
- ✧ Programming languages

Transparent Heterogeneous Distribution

- Developers of clients should be unaware of the underlying server architecture & vice-versa
- It should be possible to change the architecture of a server transparently to the client
- Client developers should not even need to know whether a server is local or remote.

Functional and Technical Architecture

The separation of functional from technical concerns is a strategy for enabling the application developer to concentrate on the specific aspects of the observatory

✧ Expressing the complexity in software of an observatory is difficult

✧ Having to know the subfields of computer science associated with distributed object architecture is also very challenging

Conclusion

Let system developers take care of the computer science-related tasks

Functional Architecture

A Functional Software Architecture (FSA) is a model that identifies enterprise functions, interactions and corresponding information technology needs.

- ✧ Software components/subsystems
  - ✧ Responsibilities
  - ✧ Interfaces
  - ✧ Primary relationships and interactions
- ✧ Physics and algorithms
- ✧ Hardware deployment and distribution

It is developed by architect and subsystem leaders

Technical Architecture

The functional architecture must be supported by a technical architecture that describes (and implements) the technical aspects of the software

✧ Access remote resources
✧ Store and retrieve data (Database technology)
✧ Manage security needs
✧ Communication mechanisms and networking
✧ Software deployment and activation
✧ Programming model

It is provided by the technical team

Separation of concerns

- ✧ Functional and technical architecture: two views
- ✧ Subsystem teams should concentrate on function
- ✧ Technical architecture provides them with simple and standard ways to, for example:
  - ✧ Access remote resources
  - ✧ Store and retrieve data
  - ✧ Manage security needs
- ✧ Keep the two concerns separate!

The key to the separation between Functional and Technical Architecture

Purpose of a framework is to:

- ✧ provide a programming model
  - ✧ Ensure that the same thing is done in the same way in all the development locations
- ✧ provide common paradigm abstractions
- ✧ mask heterogeneity
- ✧ satisfy performance, reliability and security requirements

The ALMA Common Software (ACS) Framework

- ACS provides the basic services needed for object oriented distributed computing. Among these:
  - Transparent remote object invocation
  - Object deployment and location based on a container/ component model
  - Distributed error and alarm handling
  - Distributed logging
  - Distributed events
- The ACS framework is based on CORBA and built on top of free CORBA implementations.
- Model driven development with code generation

Supported Platforms

- Operating system: RHEL 5.5 and 6.5 (32 and 64 bits)
  - CentOS/SL 5 and 6 binary compatible
  - Other linux versions supported by external projects
  - Windows added also by external initiatives
- Real-time: RTAI
  - VxWorks supported by and for APEX
- Languages: C++, Java, Python
- CORBA middleware: TAO (C++), JacORB (Java), Omniorb (Python), CORBA services.
- Embedded ACS Container: PC104, Debian, 300Mhz Geode, 256MB RAM, 256 MB flash (CosyLAB microIOC), …

LGPL and open source software

The strategy to provide common features to users is:

- Use as much as possible open-source tools, instead of implementing things.
  - Do not reinvent the wheel
  - Reuse experience of other projects
  - Do not pay for licenses
  - Support from user community
- Identify the best way to perform a task among the possibilities
- Wrap with convenience and unifying APIs

ACS is distributed under the LGPL license

Open source software may have drawbacks:

- Fast lifecycle and support only of the newest
- Free/commercial support
- Documentation not as good as commercial products

Separation of roles

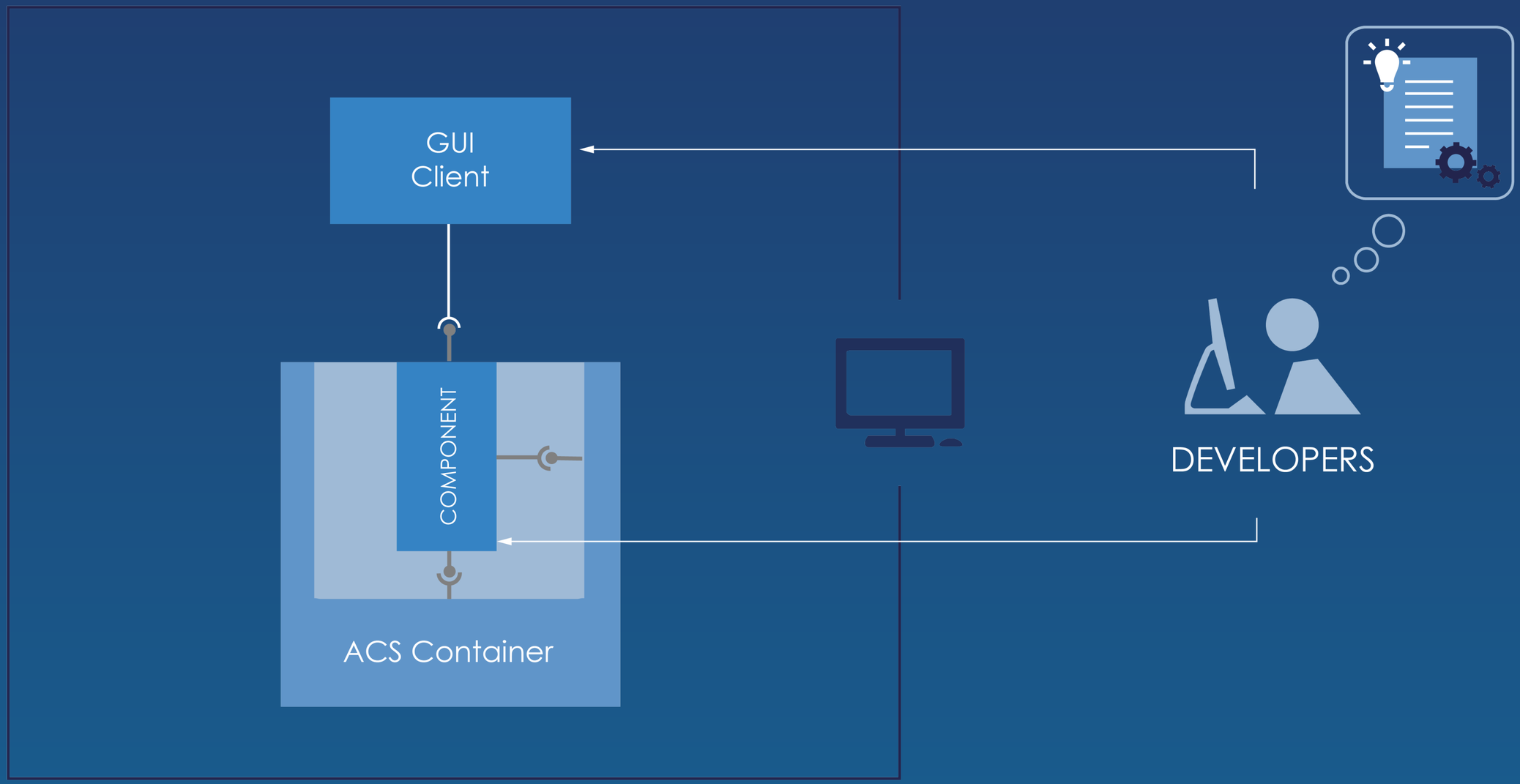
ACS keeps separate 3 roles/phases:

- ✧ Development by software developers
- ✧ Deployment by deployment engineers
- ✧ Runtime by system operators

Development

- ✧ Developers write components and graphical user interfaces clients in C++, Java, or Python.
- ✧ ACS provides an integrated build environment based on application code modules.
- ✧ Communication from an application to a component, and among components, uses ACS as middleware.
- ✧ No thinking about starting and stopping components, or on which machine they should run later.

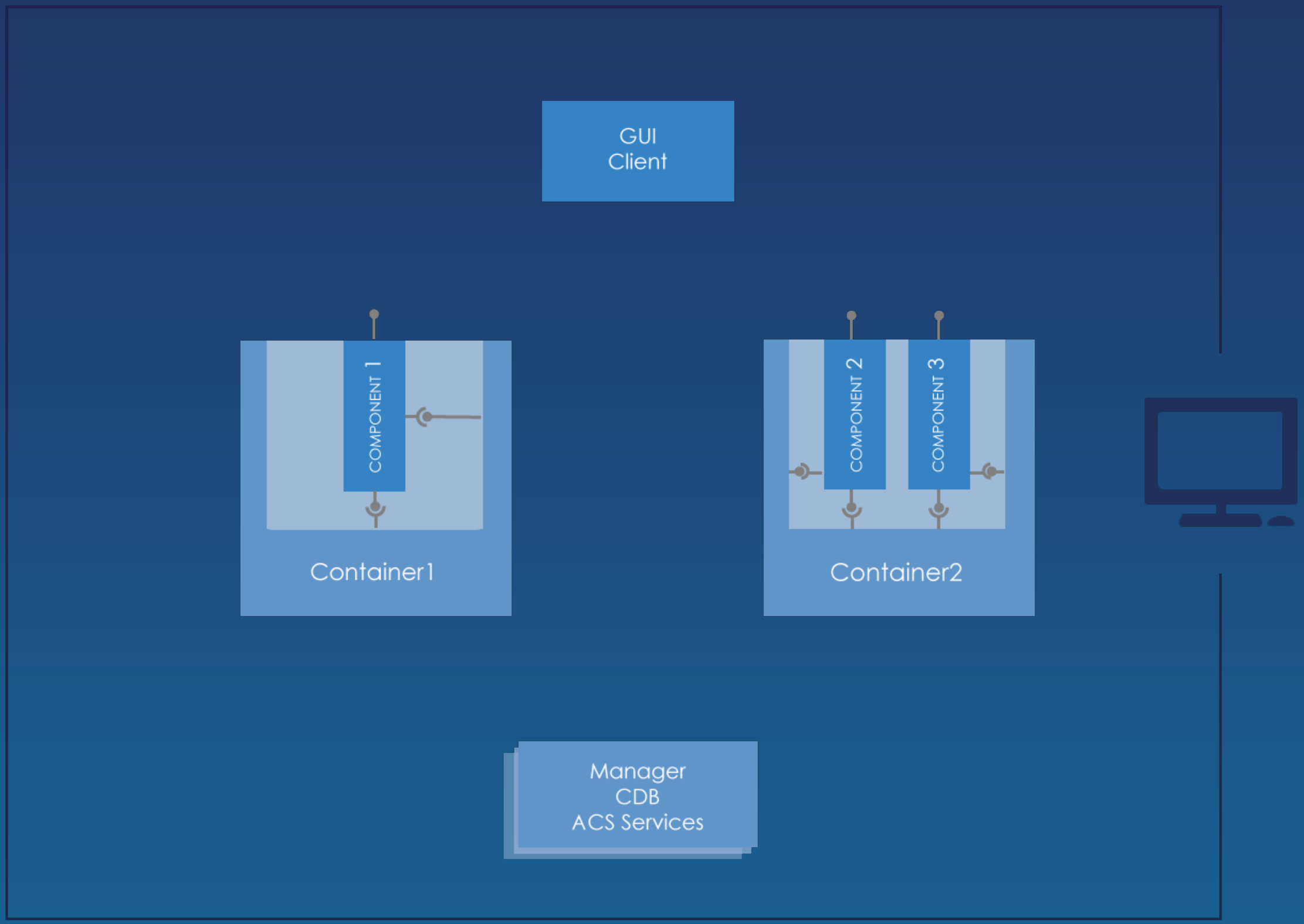
Development



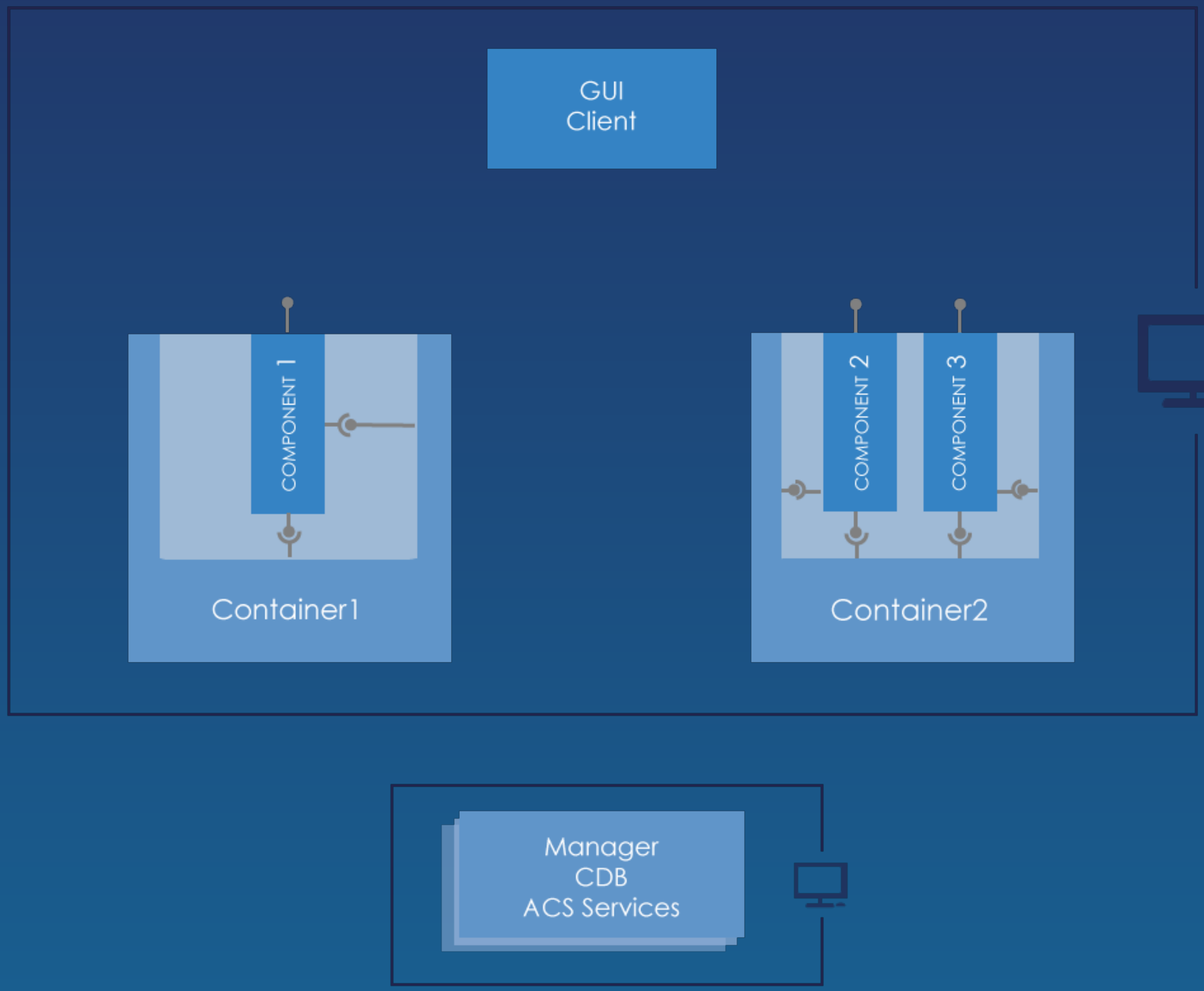
Deployment

- ✧ One or more containers get assigned to each computer.
- ✧ Components get assigned to containers.
- ✧ This location information is stored centrally in the Configuration Database (CDB).
- ✧ Other configuration data for containers and components are also stored in the CDB.
- ✧ There can be different deployments for unit tests, system tests, and various stages of the production system.

Deployment


GUI
Client
COMPONENT 1
Container1
COMPONENT 2
COMPONENT 3
Container2
Manager
CDB
ACS Services

Deployment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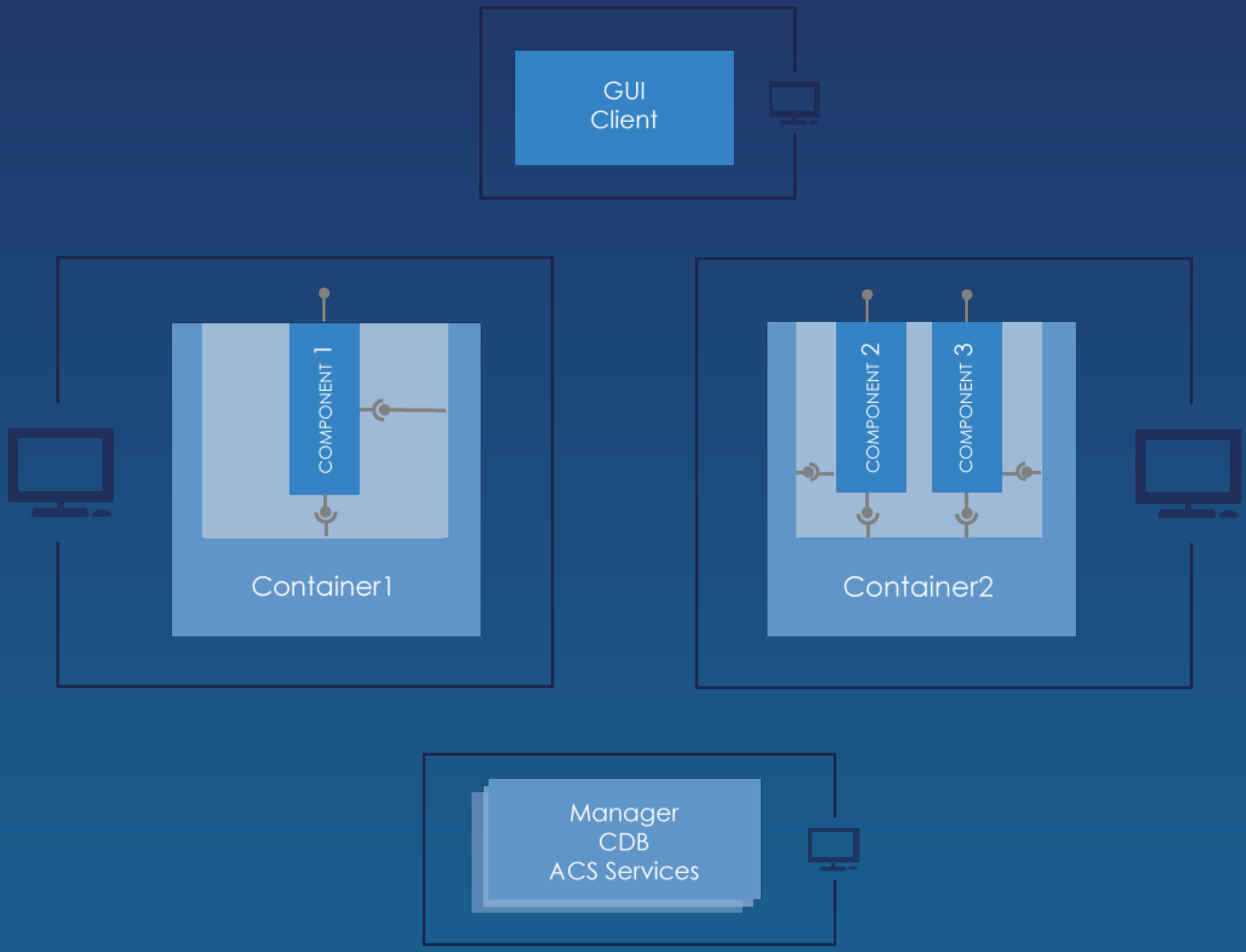
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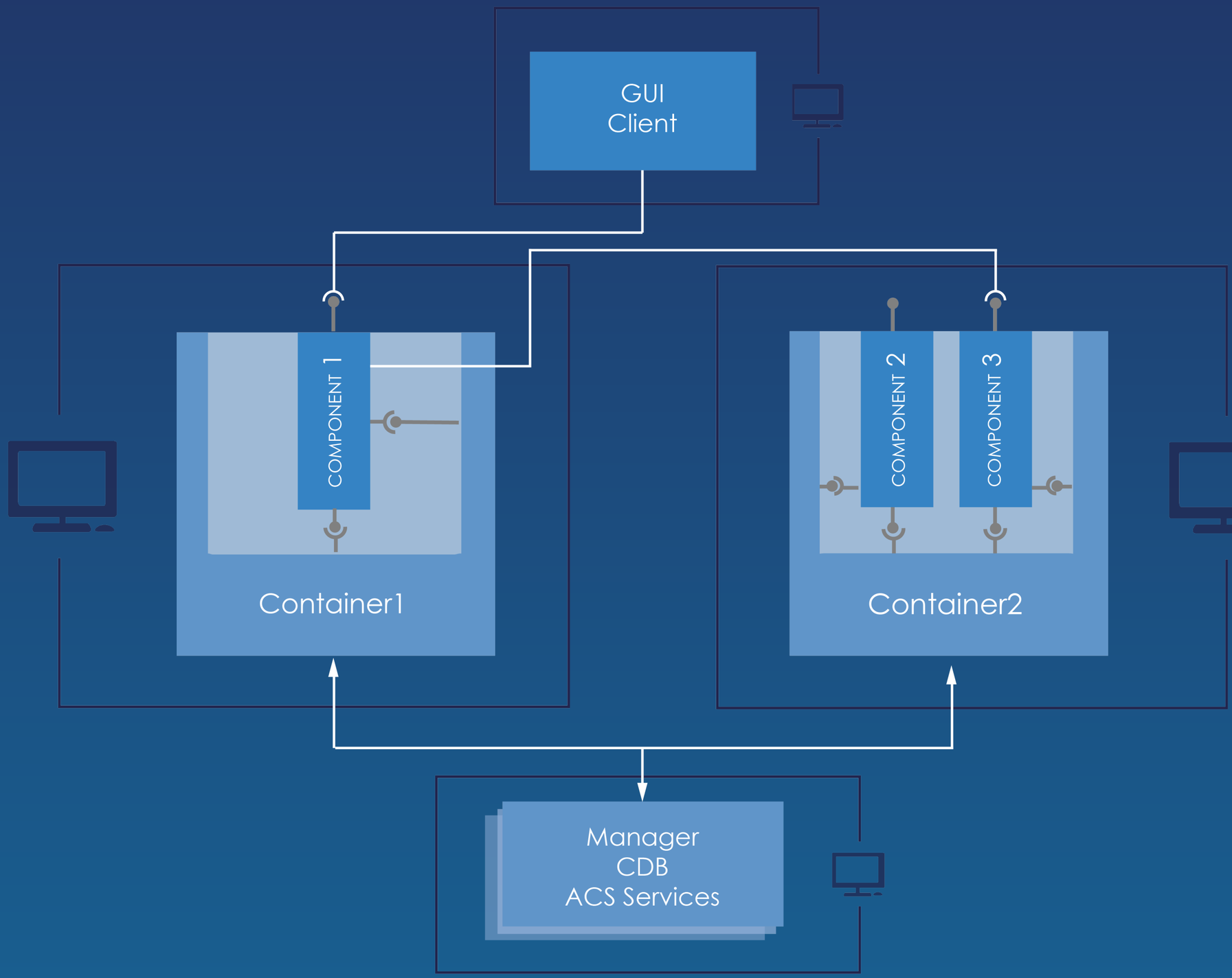
Runtime

- ACS containers start and stop components (lifecycle management) as needed.
- Containers provide components and clients with references to other components.
- The Manager is the central intelligence point that keeps the system together. Components never see it directly.
- Manager, CDB, and other services, are started with the “acsStart” command or with the ACS command center GUI.

Runtime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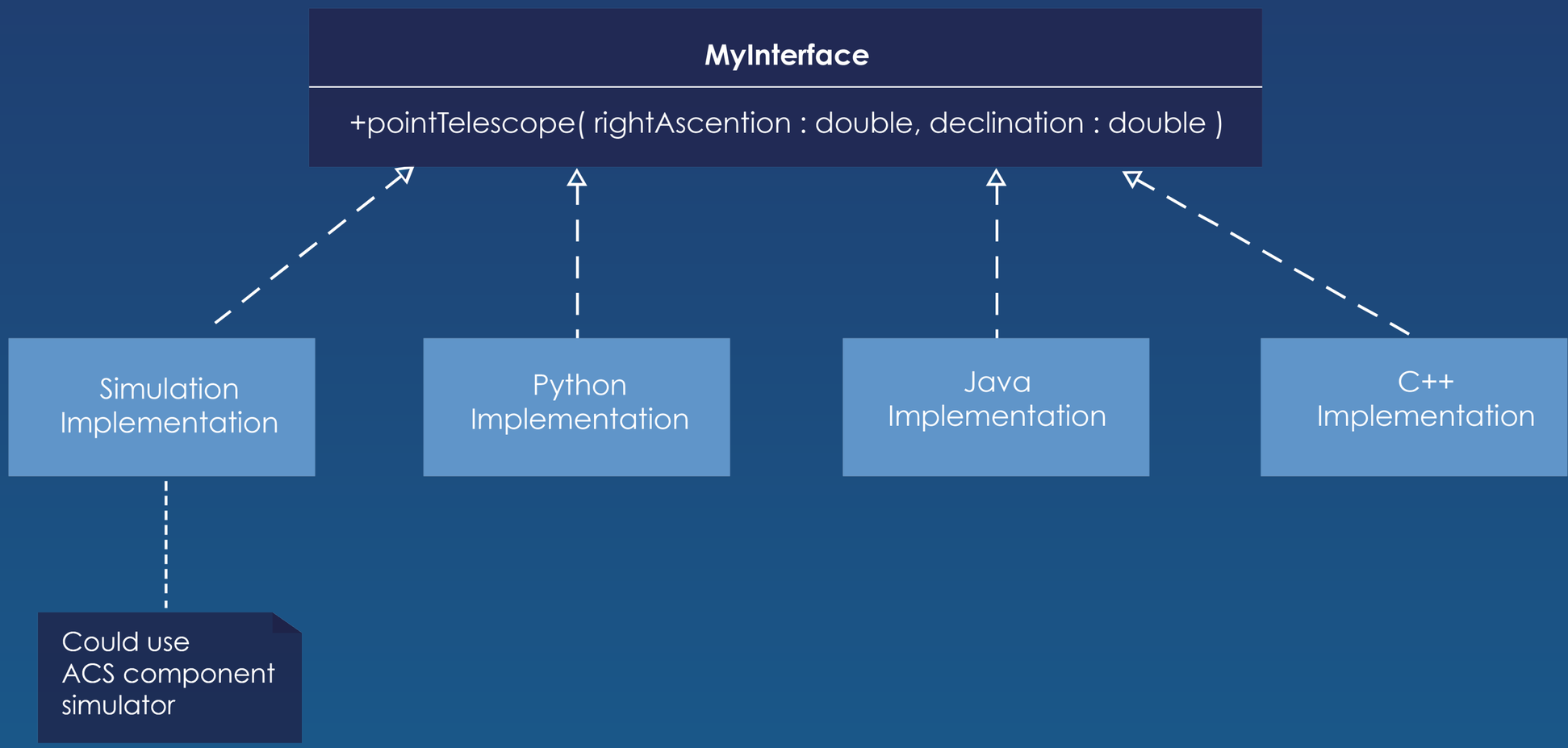
Interfaces versus Implementations

- First step: Identify objects
  - Mount
  - Camera
  - Telescope
  - Observation
  - Exposure
- Second step: Define interfaces
  - Implementation comes later and is independent of interface
  - Deployment is also independent of interface definitions
  - Interfaces shall be kept as stable as possible, but it must be possible to have them evolve when needed.
  - A formal interface definition language is needed

One Interface, many implementations



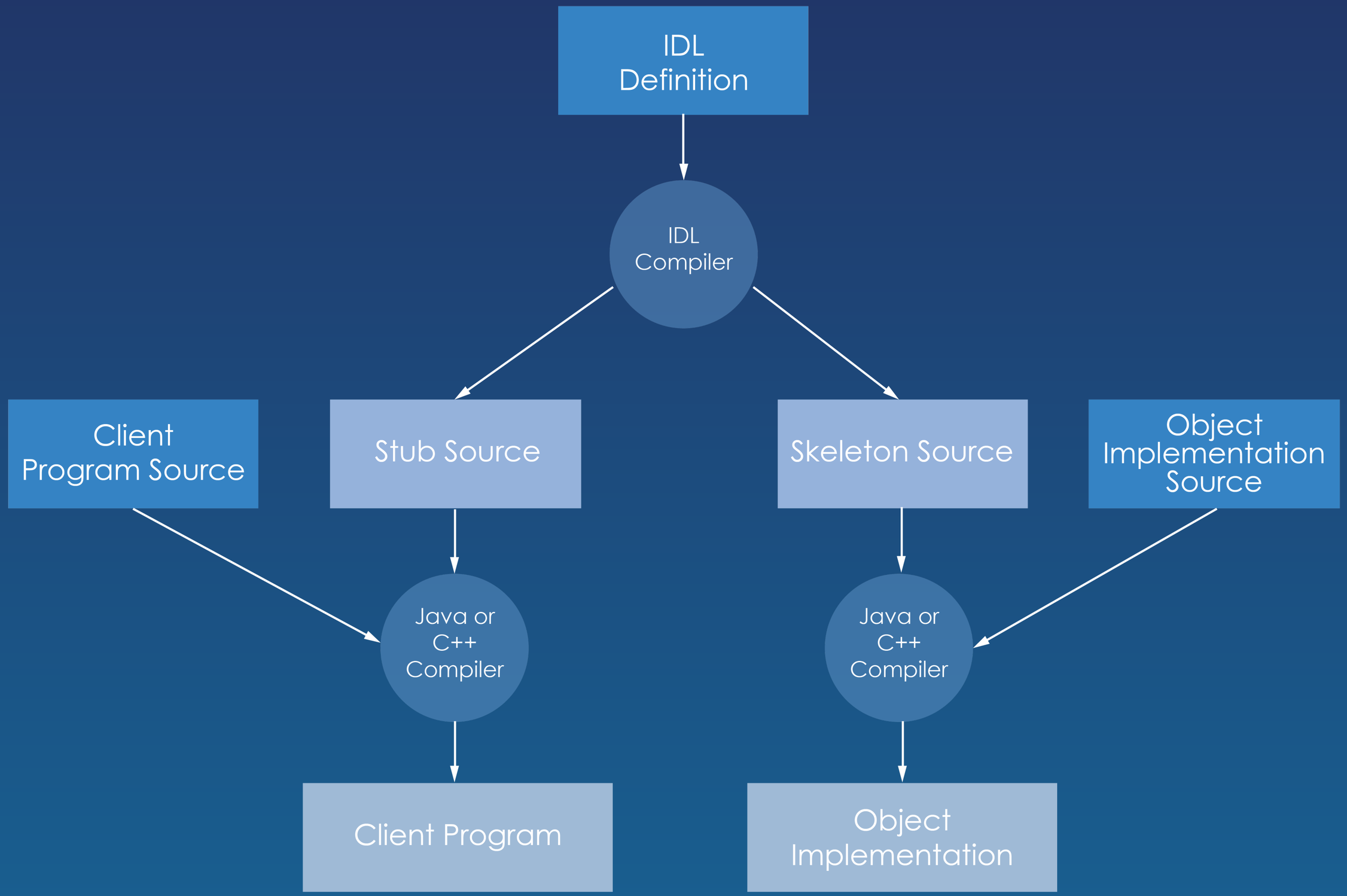
Interface Definition Language (IDL)

- ✧ CORBA and DDS both use the same formal interface definition language: IDL

  IDL forms a ‘contract’ between client and servant or publisher and subscriber

- ✧ IDL reconciles diverse object models and programming languages
- ✧ Imposes the same object model on all supported languages
- ✧ Programming language independent means of describing data types and object interfaces
  - ✧ purely descriptive - no procedural components
  - ✧ provides abstraction from implementation
  - ✧ allows multiple language bindings to be defined
- ✧ A way to integrate and share objects from different object models and languages

Development Process



Questions?

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