

The ALMA Common Software

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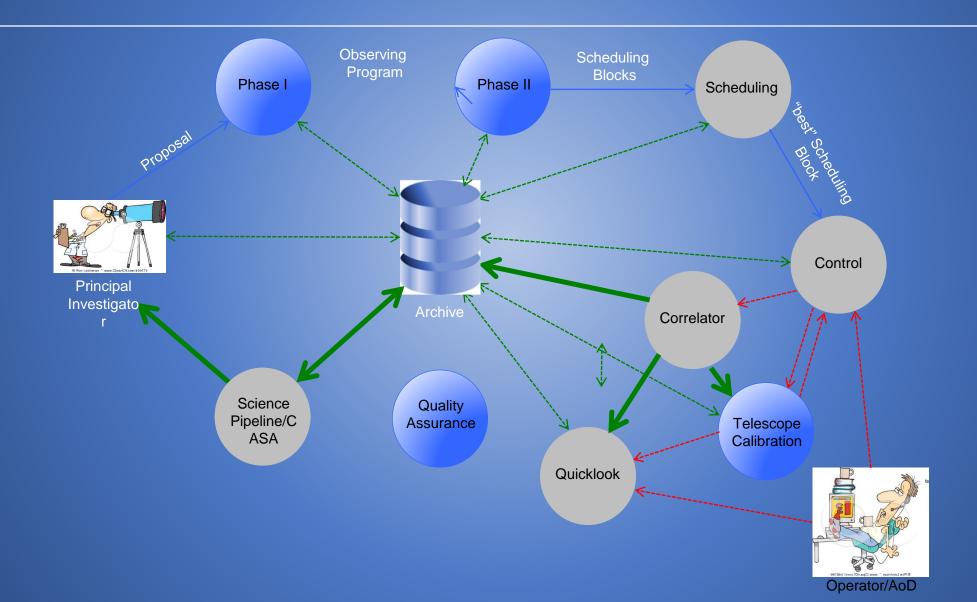




- What is ACS
- ACS services
- Component-Container paradigm
- Development
- Deployment
- Run-time

End-To-End data flow

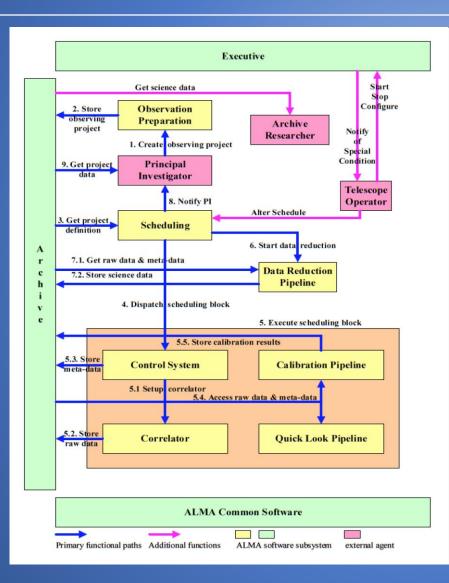


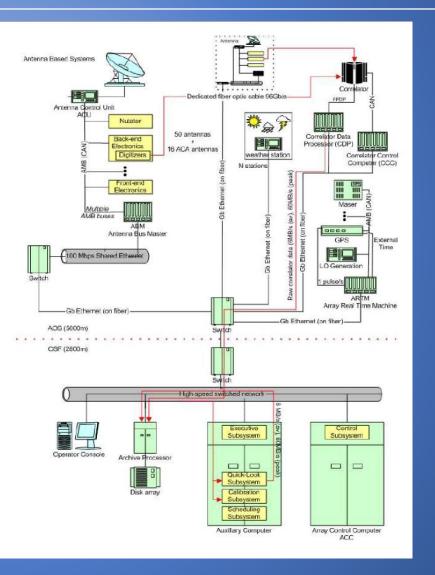




ALMA – software and physical architecture









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
- Servers and clients may use different:
 - ♦ Hardware
 - ♦ System software
 - ♦ Programming languages







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



The ALMA Common Software (ACS



- 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

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The ACS framework is based on CORBA and built on top of free CORBA implementations.







♦ 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 free software



- ♦ Use as much as possible open-source tools, instead of implementing things.
 - \diamond Do not reinvent the wheel
 - \diamond Reuse experience of other projects
 - \diamond Do not pay for licenses
 - ♦ Support from user community
- ♦ Wrap with convenience and unifying APIs
- ♦ ACS is distributed under LGPL license
- ♦ Open source projects may have drawbacks
 - ♦ Fast lifecycle and support only of the newest
 - ♦ Free/commercial support
 - ♦ Documentation not as good as commercial products









- Naming service
- Interface Repository
- Notify Service*
- Logging Service
- Configuration database
- Alarm system
- Manager



ACS for developers

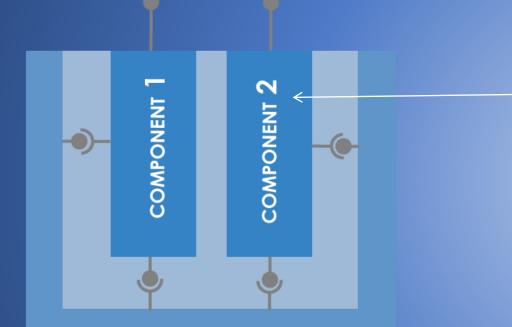


- Developers write components and graphical user interfaces clients in C++, Java, or Python.
- ACS provides an integrated build environment based on application code modules.
- ♦ Communication from an application to a component, and among components, uses ACS as middleware.
- No thinking about starting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



Container/Component





Components provide specific functionality to the system. They are started and stopped by the container, whom offers the component services

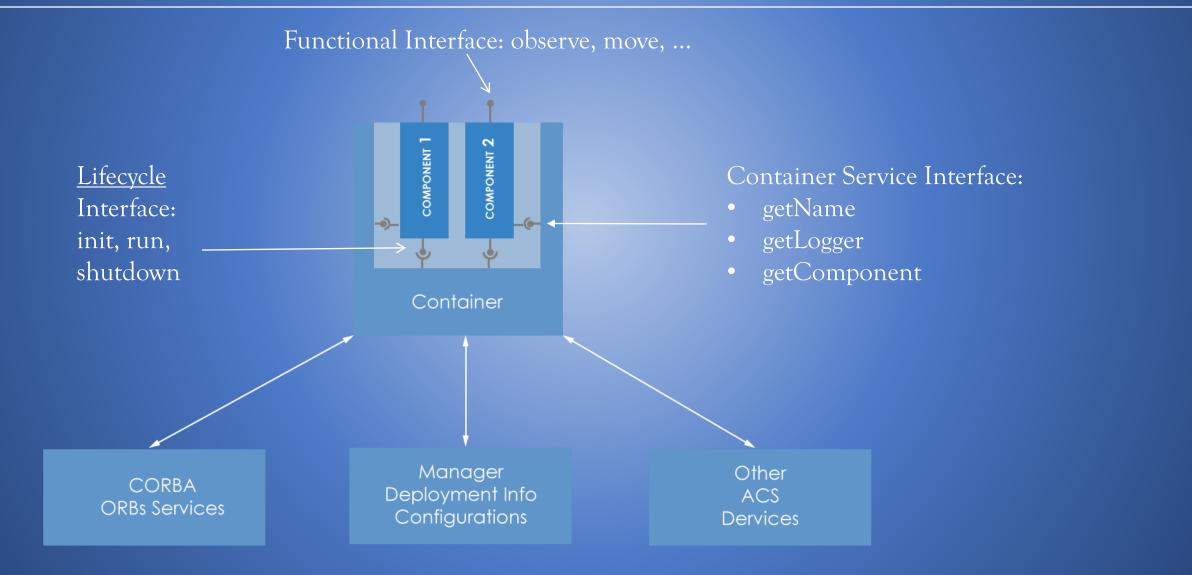
ACS Container

The container only cares about the lifecycle interface of the components deployed on it



Container/Component interfaces









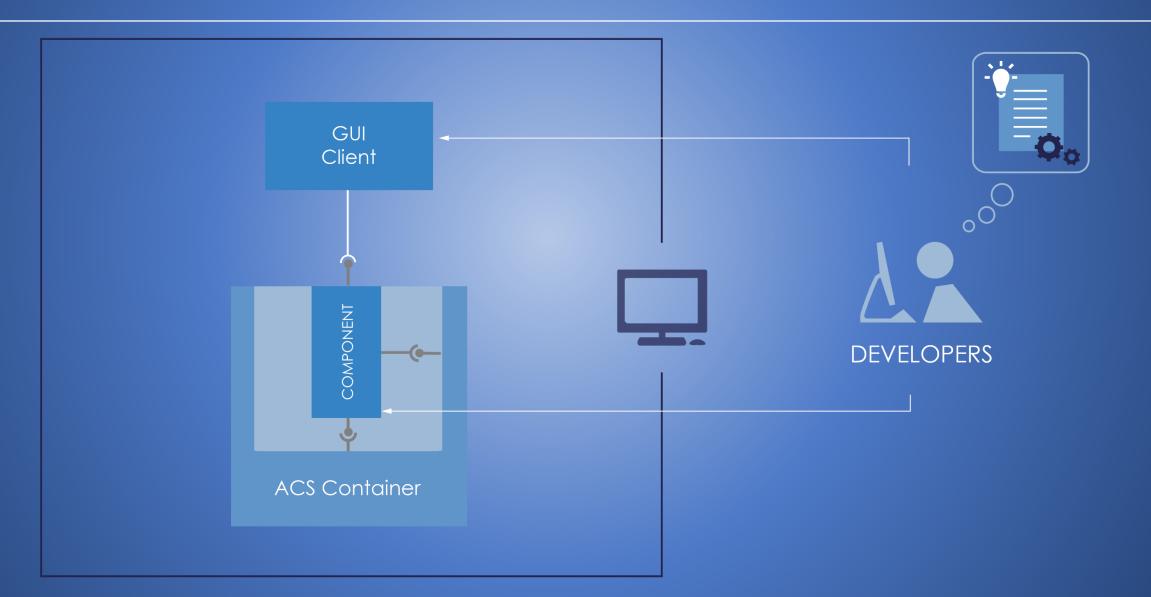


- ♦ First step: Identify objects
 - ♦ Mount
 - ♦ Camera
 - ♦ Telescope
- ♦ Second step: Define interfaces
 - ♦ Implementation comes later and is independent of interface
 - ♦ Deployment is also independent of interface definitions
 - Interfaces shall be kept as stable as possible, but it must be possible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



Development - 2

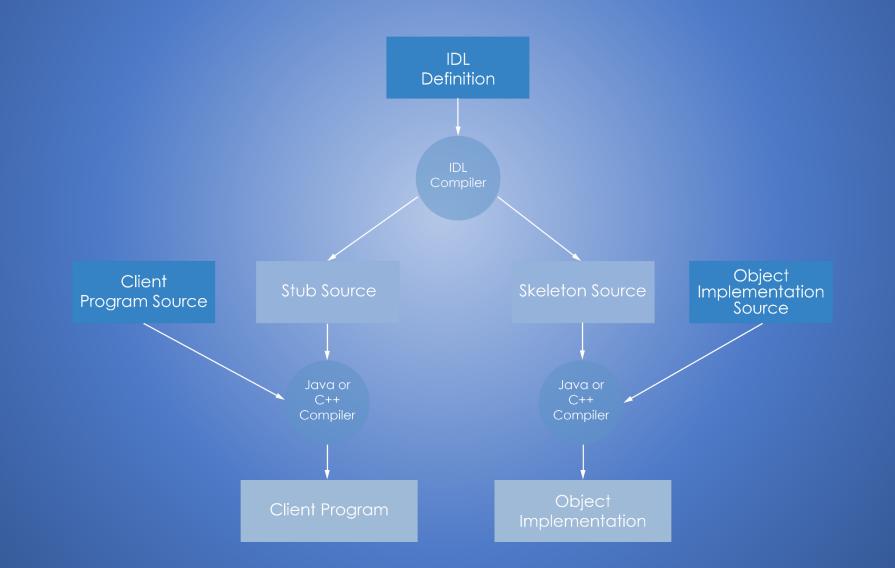






Development - 3

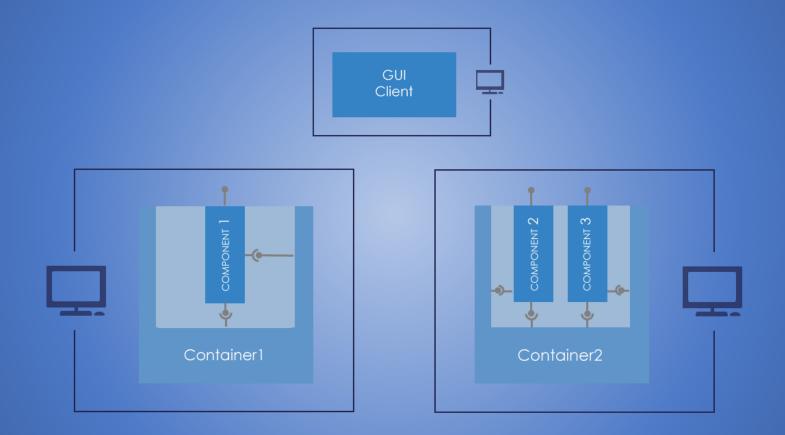






Deployment







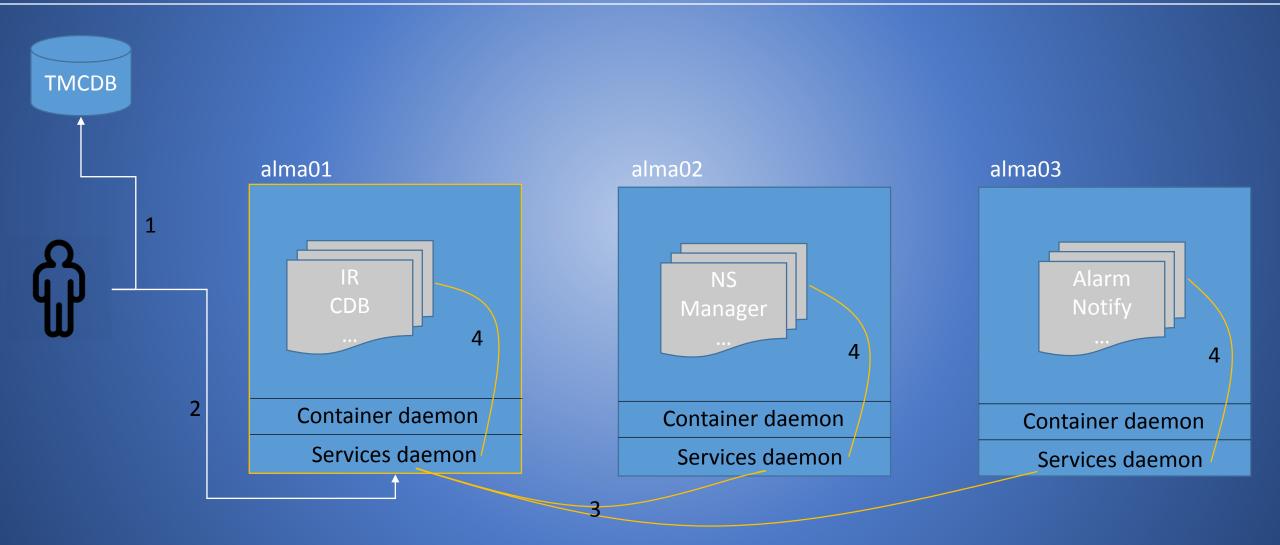




Acs Command Cent	ei	Hel
Common Settings Acs Instance O Cdb Root Dir /alma/ACS-2014.2/acsdata/config/defaul © Localhost (single-machine project) © Remote (distributed project) © Use built-in ssh O Use native ssh O Use Acs Daemons Host User Pwd Containers	Acs Suite Start Stop <u>K</u> ill ad <u>v</u> anced	Deployment Info
Name Type Remote Host		



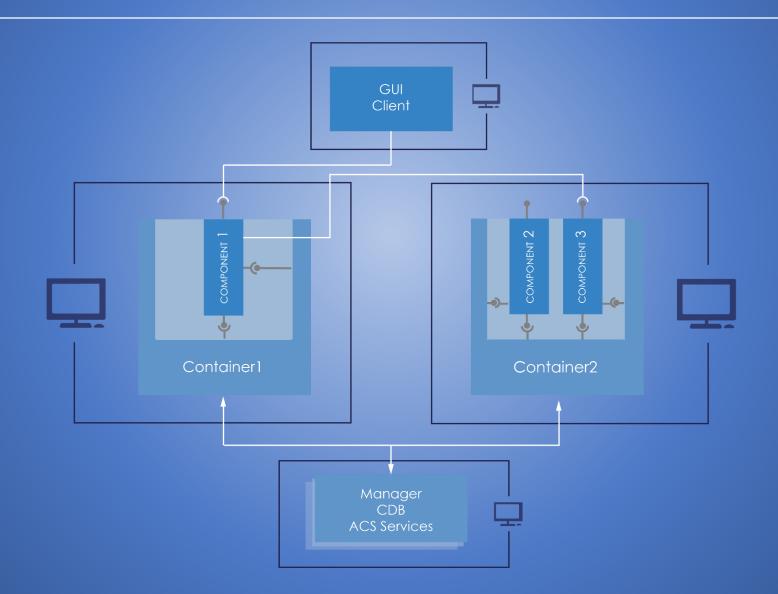






Runtime

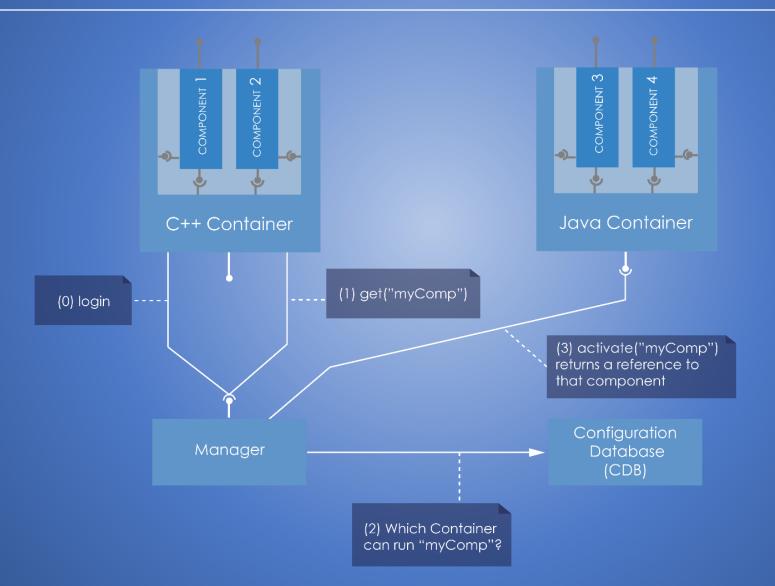






Component activation

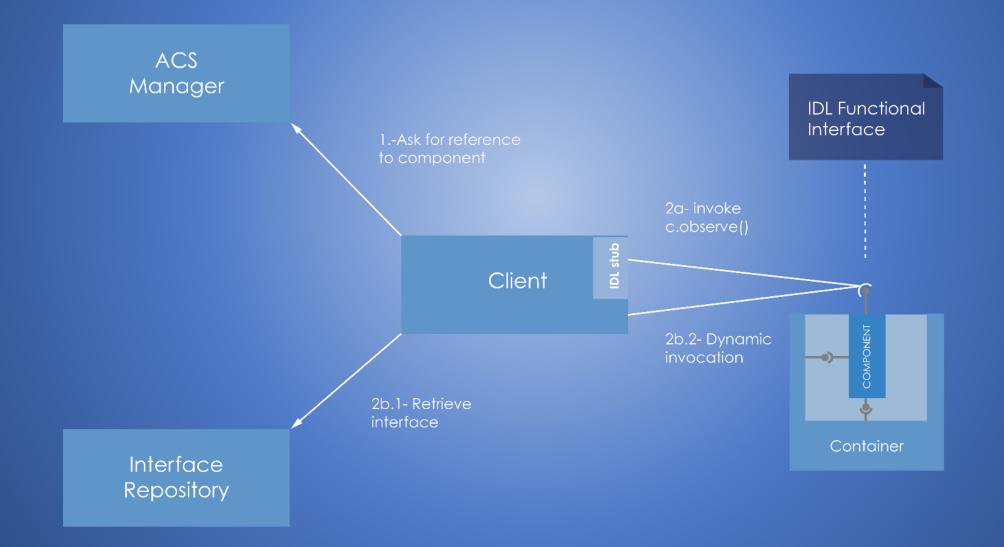




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Component client







Object explorer



By type By device	Object: MOUNT2	Show special operations and attributes	
Search	Operations	Attributes	
Artniveconnecti	descriptor ()	componentState	
- 🙅 ErrorComponen	find_characteristic (String)	name	
🕶 👼 Filter Wheel	get_all_characteristics () get_characteristic_by_name (String)		
🕶 👼 FridgeControl	objfix (double, double, <cbvoid>, <datastru< td=""><td></td></datastru<></cbvoid>		
🗠 🙅 HelloDemo	obstar (double, double, double, double, double, dou		
🗠 🙅 Identifier 🛛 🗧	,,,,,,,,,,,,,,,,,,,		
🗠 🙅 Lamp			
🗠 🎪 LampAccess 👘 👘			
🗠 🎪 LampCallback 👘			
🗠 🎪 LampWheel			
r 🙅 Mount			
P MOUNT2			
- 📑 actAz			
• 📑 actEl			
► CmdAz ► CmdEl ▼			
Aessage: Initializing BACI e	-		
1essage: Starting engine ir 1essage: Obtained referer			
lessage: Obtained referer			
lessage: Querying root no			
Aessage: Querying type no Aessage: Connecting to 'Ma			
Aessage: Connecting to Mi Aessage: Connected to 'Mi			
lessage: Analysing attribu			
lessage: Analysing operat	ions for 'MOUNTO'		





- Executed within a container running on a given machine
 Container spawns threads for component execution
- ♦ Follows a component lifecycle
- A Component is the natural base class for physical and logical "devices" (abstraction of hardware devices)
 - ♦ With properties (e.g. staus value, position control/monitor points)
 - ♦ Characteristiscs i.e static data in the configuration database
 - ♦ units, default values, monitor*, alarm*, archive*



BACI property

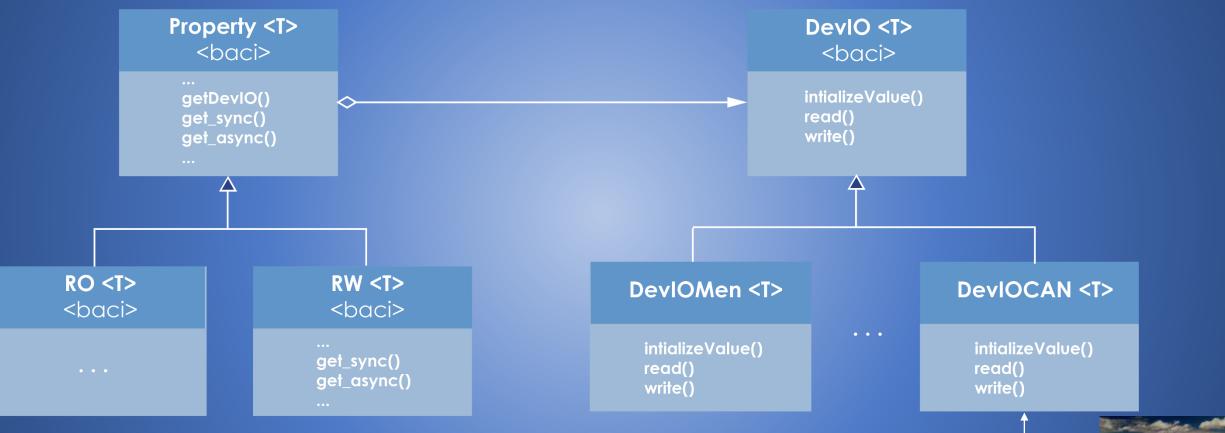


- ♦ Statically defined item
- ♦ It has a typed value and attributes
 - ♦ Basi ctypes: double, long, string, pattern, enum, longSeq, …
- ♦ Read-only (RO) and read-write (RW) access
- ♦ Defines a interface, which is extended by developer
 - Developer implements functions read() and write() functions
- ♦ Combines value(s) with "attributes"
 - ♦ Description
 - ♦ Unit
 - ♦ Monitoring parameters
 - ♦ Alarms thresholds
- ♦ Value monitoring
 - ♦ Interval
 - ♦ On change
 - ♦ Keeps history (last 10 values)
- ♦ Value archiving
 - ♦ Same as for monitoring
- ♦ Alarms built-in

















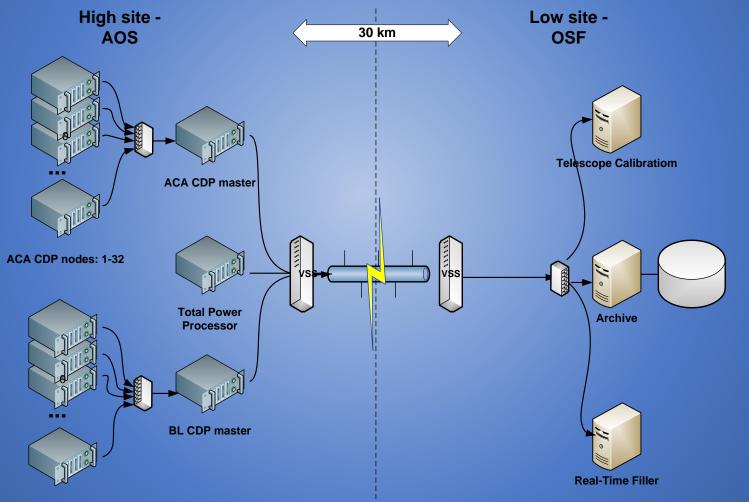
 ACS service for reliable and concurrent streaming of high volumes of (astronomical) data
 Used in two configurations:
 Many senders to one receiver
 One sender to many receivers – multicast

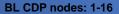
Used by 6 ALMA SW sub-systems
 In operation since March 2013
 Total peak data rate: 64MBytes/sec



Bulkdata - 2



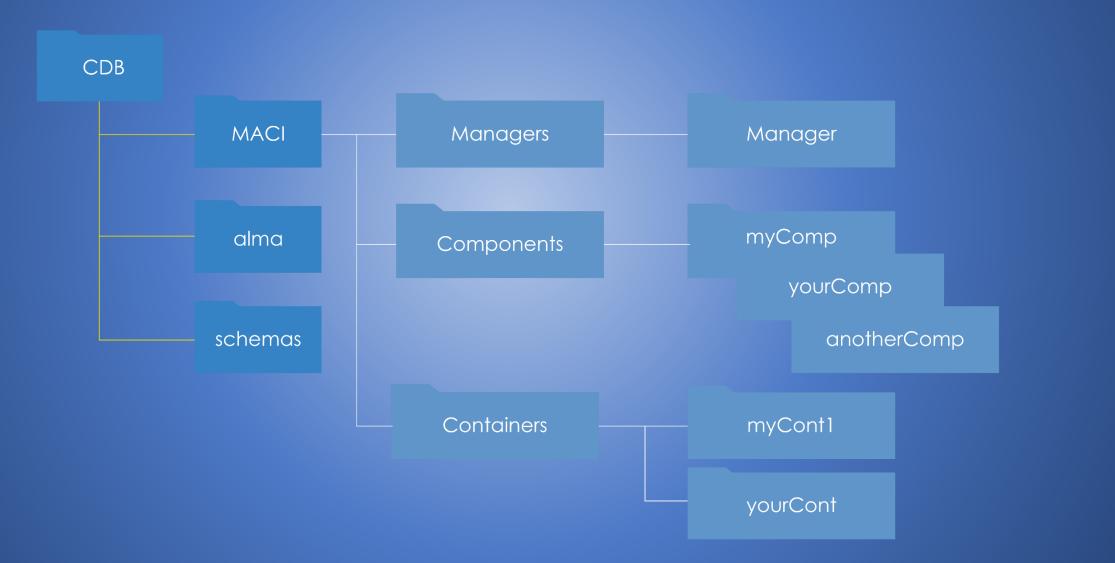






Configuration database (CDB)





CDB browser

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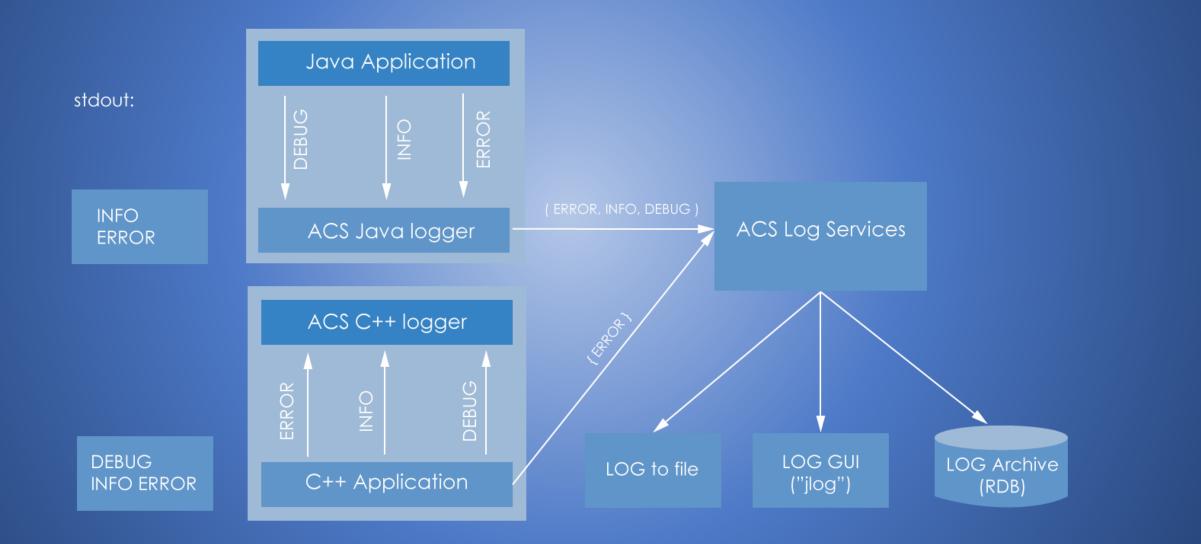


💰 Configuration Database Browser		
<u>File E</u> dit <u>A</u> dministration		
Refrest CDB Tree	CURRENT LOCATION:	/root/MACI/Containers/bilboContainer
root	Save Changes to XML record	Reset Data
 ← ☐ Containers ← ☐ bilboContainer ← ☐ Autoload ← ☐ LoggingConfig 	Table View XML View ATTRIBUTE NAME DALtype ImplLang	ATTRIBUTE VALUE DAL cpp
 	ManagerRetry Recovery ServerThreads Timeout UseIFR	10 true 5 20.0
Components Gama G	xmins xmins:baci xmins:cdb xmins:log	urn: schemas-cosylab-com: Container: 1.0 urn: schemas-cosylab-com: BACI: 1.0 urn: schemas-cosylab-com: CDB: 1.0 urn: schemas-cosylab-com: LoggingConfig: 1.0
←	xmins: xsi	http://www.w3.org/2001/XMLSchema-instance
← TEST.PS.2 ← TEST.PS.9 ← PBUMP_B_01		



Logging system





Logging client (jlog)

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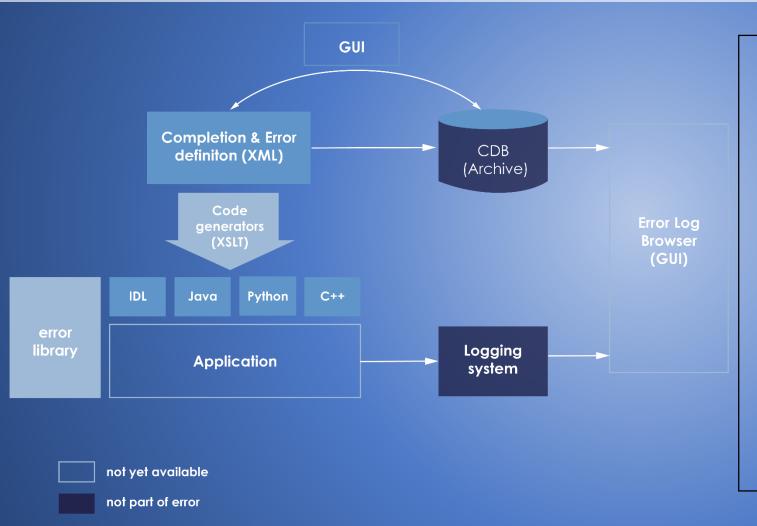


X 🖸	LoggingClient - Online <@alma>			\odot \odot						
File View Search Drill down Expert										
Log level: 🔯 Debug 🔻 Disca	rd level: 🔯 Debug 🔻 🕕 Pause 📑 Clear I	ogs	ogs Filters Drill down							
	Search_									
TimeSt 👻 Entry Type Source Ob	. Log Message	De	etailed info							
10:04:22 (1) Info Manager 10:04:22 (1) Info Manager	Component 'curl:///MOUNT3' provided to Component 'MOUNT3' (Handle (0x1000005) = { type		LogField imeStamp	Value 2015-03-24T10:04:21.922						
	Component 'MOUNT3' activated.		ntry Type	() Info						
	Switched state of component MOUNT3: INITIALIZED ->		ource Object	Manager						
	Switched state of component MOUNT3: NEW ->	Fi	-	Managerimpi, java						
	Switched state of component MOUNT3: INITIALIZING	Li	ne	6622						
10:04:21 🤤 Info 🦳 Manager 10:04:21 🥥 Info Manager	Component 'curl:///CDB' provided to 'MOUNT3'. 'MOUNT3' requested component 'curl:///CDB'.	R	outine	internalNoSyncRequestComponent						
10:04:21 (3) Info mariager		H	ost	alma						
	yraii pani yRequest to load 'acsexmplMountImpl'.	Pr	OCESS	Manager						
10:04:21 Dinfo Manager	ObjectExplorer' requested component	C	ontext							
10:04:21 Info Manager	Activating component 'MOUNT3' (Handle (0x1000005)		hread	RequestProcessor-5						
10:04:10 () Info Manager	Component 'curl:///MOUNT1' provided to		og ID	165						
10:04:10 🛈 Info Manager	'ObjectExplorer' requested component		riority							
10:03:59 😲 Info Manager	Component 'curl:///NameService' provided.	U								
10:03:59 🛈 Info Manager	Request for component 'curl:///NameService' issued.		ack ID							
l'international and an and a second	integress for component carry, interness are insuce.	St	ack Level							
		Lo	og Message	Activating component 'MOUNT3' (Handle (0x1000005) = { type = COMPONENT, key = (0x0), id = (0x5) }) on container 'bilboContainer'.						
		A	udience							
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		100	0K Engine not fi	Itered Table not filtered Engineer 🔒 😜						



Error system





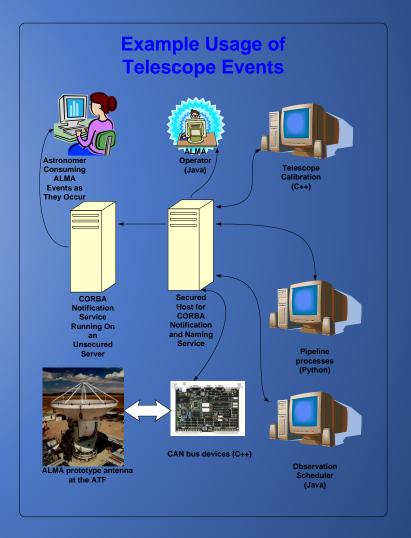
ErrorTrace (TimeStamp=Thu Oct 31 20:45:04 2013,
FileDelayCal.py,
Line=579,
Routine= <module>,</module>
Host=gns,
Process=14355,
Thread=MainThread,
Type=10, Code=3,
ShortDescrip=Unknown Error,
Severity=Error,
Data:)
ErrorTrace (TimeStamp=Thu Oct 31 20:45:04 2013,
File=ArrayMountControllerImpl.java,
Line=1987,
Routine=throwIfIllegalParameterError,
Host=gas01,
Process=CONTROL/ACC/javaContainer,
Thread=RequestProcessor-177,
Type=10000, Codee=2,
ShortDescrip=Illegal Parameter Error,
Severity=Error,
Data: Name=DV02,







- Events distributed by means of Notification Channels
- NCs are an alternative to direct "Request/Reply" calls.
- NCs decouple the communicating partners
- NCs can protect the sender from slow receivers
- Notification Channels runs inside CORBA Notify Services
- Publisher/Subscriber mechanism
 - ACS handle CORBA details of NCs
- Use of NCs makes debugging the system more difficult.
- Experimental NC over DDS





Event browser



X ALMA ACS Event Browser									
Event Browser Help									
🔿 Notify Service Summary 🥥 Channel Tree 🛛 🤣 🔊 🗢	🦉 🔵 Event List 🥥 Archivi	ing List		Event type filter:					
Notify Service #cons #suppliers	Timestamp	Event source	# Evel Event type	# Events this type					
Alarm 0 0									
Archive 0 0									
DefaultNotifySer 0 0									
Logging 0 0									
	event Details								
	Name	Туре	Value						
		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Value						
Refresh service data to get correct supplier/consumer info.									







The Alarm System is a messaging system that deals with abnormal situations by means of Fault States (FS):

- FS collection
- FS analysis and distribution (reduction rules)
- Alarm definition
- Alarm archiving
- ACS comes with 2 implementations:
- ACS (default)
- CERN (explicitly set in the CDB)







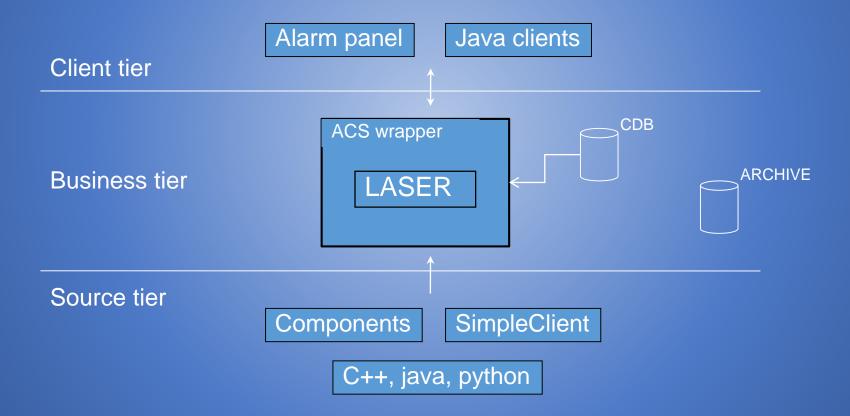


- 4 alarm levels (low, medium, high, critical)
- ACS generates alarms from BACI properties
- 2 type of reduction rules
 - NODE
 - MULTIPLICITY
- API is very easy, just one line of code



CERN Alarm System







Alarm panel



	\odot	_				Al	armPanel <@alr	na>			\odot \otimes \otimes	
ĺ	larm	5										
	×	Auto ack:	MEDIUM -	📲 🖁 Rec	duce 📃 🕕 Pau	ise Search				▶ Show	📕 Hide	
		e/2	Time		Component	Family	Cause	Description	Priority 🔺	Alarm det	ails	
					MULTIPLE_MF_FAIL.			The description for 0	VERY HI	Field	Value	
					MULTIPLE_MF_FAIL			Description 1	VERY HI	Component	ALARM_S	
	6				MULTIPLE_MF_FAIL			The description for 2	VERY HI	Source timestamp		
	6				MULTIPLE_MF_FAIL. MULTIPLE_MF_FAIL.			The description for 3	VERY HI	Cause		
					MULTIPLE_MF_FAIL.		Multiplicity	The description for 4	VERY HI HIGH	Priority	MEDIUM	
					ALARM_SOURCE_MI		Multiplicity		HIGH	Description	PS test al	
					ALARM_SOURCE_IM		Multiplicity	PS test alarm	MEDIUM	Action		
₽		2013-0	3-24110.10.3	0.211 A	ALARM_SOURCE_I	гарга		F3 test alarii	MEDIOM	Consequence		
										Status	Active	
										Host	ALMA	
										Help page:	http://te	
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												📲 💽 Reduction chain of [PS:ALARM_SOURCE_PS:1] <@al 🕑 🔿 🚿
╠										[8]		Table view Tree view
	10	3	1	1	0				Tak	ole not filtered	(3)	ALARM_SOURCE_PS 1: PS test alarm
L												🛉 😳 ALARM_SOURCE_MOUNT 1: Mount test
												Land ALARM_SOURCE_ANTENNA 1: Test antenna alarm
												Refresh Close



Alarm profiler



🗙 Alarms profiler					
File					
MostFrequent Stale Chatter	ing 🗖 Statistics	🗖 Annunciated 🗖 Sup	pressed 🗖 Lost so	ources	
Alarm ID	# ACTIVE	Activation time	# TERMINATE	Termination time	[
RR:M2:2	90	012-07-06 15:03:33.63	102	2012-07-06 15:03:36.608	
RR:M2:1	100	012-07-06 15:03:40.56	101	2012-07-06 15:03:40.788	
RR:M1:2	91	012-07-06 15:03:38.80	92	2012-07-06 15:04:02.868	
RR:M1:1	99	012-07-06 15:03:32.09	113	2012-07-06 15:03:41.338	
RR:DefaultFM_99:2	1	012-07-06 14:51:49.51	1	2012-07-06 14:52:21.866	
RR:DefaultFM_998:2	1	012-07-06 14:59:30.97	1	2012-07-06 14:59:52.794	
RR:DefaultFM_992:1	1	012-07-06 14:59:58.96	1	2012-07-06 15:02:38.847	
RR:DefaultFM_991:2	1	012-07-06 15:00:09.68	1	2012-07-06 15:02:38.737	
RR:DefaultFM_98:2	1	012-07-06 14:58:14.54	1	2012-07-06 14:59:52.464	
RR:DefaultFM_989:1 0			1	2012-07-06 14:49:48.582	
RR:DefaultFM 983:1	1	012-07-06 14:51:01.96	1	2012-07-06 14:52:21.756	
🗖 Alarms per 10 min				🗖 Alarm flood	
Alar	ms per 10	minutes		Entry	Value
				Actually in flood	Yes
3000				Avg. alarms per flood	0.00
				Highest num. of alarms in flood	0
2000	·			Monitoring time	00:20:32.424
			— nAlarms	Num. of floods	0
# 1000 -			- Threshold	Time of Alarm service in flood	00:20:32.414
1000 -				Tot. alarms in floods	1692
14:45 14:46 14:47 14:48					
	Time				







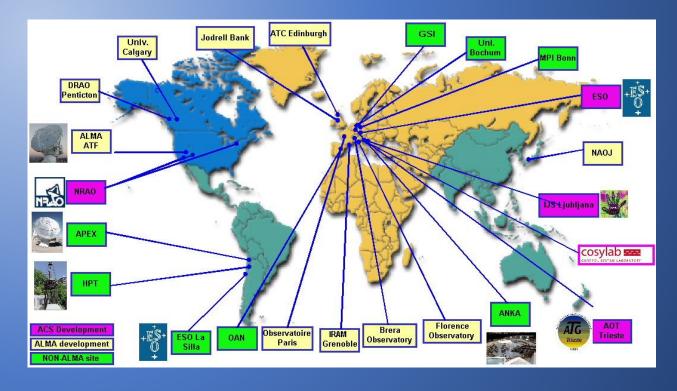
- Incremental releases (~4 releases/year)
- Feature complete
- Improving robustness
- Tools to help debugging
- Open to community after testing at the OSF



ACS outside of ALMA



- APEX
- Cherenkov Telescope Array (CTA)
- Large Latin America Millimiter Array (LLAMA)
- Radiotelescope IGN Yebes
- Sardinia Radio Telescope (SRT)
- Sparta@ESO









- Cons
 - Monolitic
 - Steep learning curve
 - Not yet complete
 - Slow evolving
- Pros
 - ACS is used in ALMA operations
 - Other telescopes uses ACS as well
 - Growing community (ACS@github)
 - C++, python and java (other languages possible)







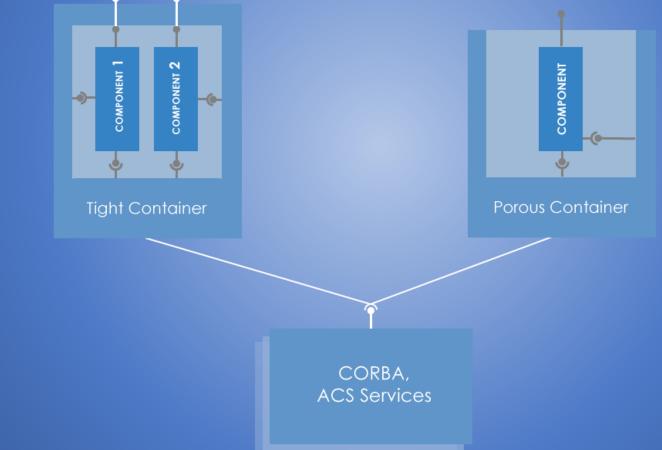




Tight and porous interfaces



Functional interface is intercepted by the container for logging and/or exception handling, security, ...

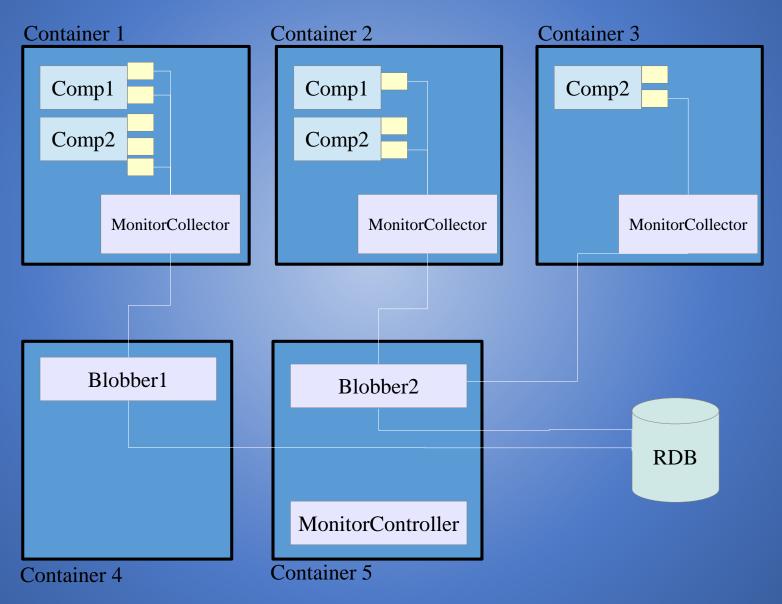


Container manages lifecycle and offers services, but exposes the component's functional interface directly – less overhead



Monitoring - 1







Monitoring - 2



