SS ZG653 (RL 5.1): Software Architecture

Modifiability and Its Tactics

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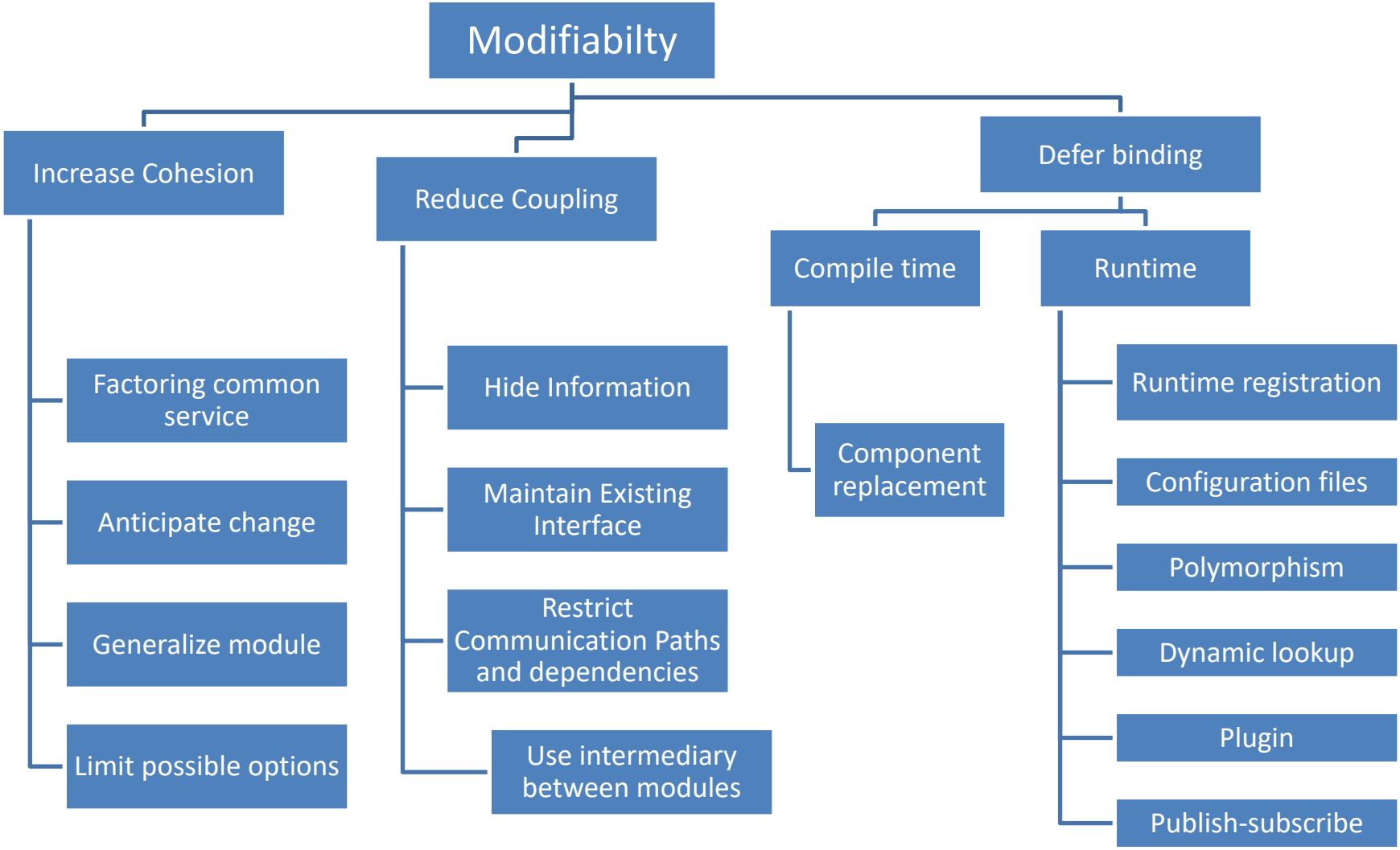
Modifiability

- **Ability to Modify the system based on the change in requirement so that**
  - **the time and cost to implement is optimal**
  - **Impact of modification such as testing, deployment, and change management is minimal**
- **When do you want to introduce modifiability?**
  - **If (cost of modification w/o modifiability mechanism in place) > (cost of modification with modifiability in place)+ Cost of installing the mechanism**

Modifiability Scenarios

WHO	STIMULUS	IMPACTED PART	MITIGATING ACTION	MEASURABLE RESPONSE
• Enduser • Developer • SysAdm	They want to modify ➢ Functionality ➢ Add, modify, delete ➢ Quality ➢ Capacity	UI, platform or System •Runtime •Compile time •Design time •Build time	When fault occurs it should do one or more of ✓ Locate (Impact analysis) ✓ Modify ✓ Test ✓ Deploy again	• Volume of the impact of the primary system (number, size) • Cost of modification • Time and effort • Extent of impact to other systems • New defects introduced
Developer	Tries to change UI	Artifact – Code Environment: Design time	Changes made and unit test done	Completed in 4 hours

Modifiability Tactics



Dependency between two modules (B→ A)

Syntax (compile+runtime)

- Data : B uses the type/format of the data created by A
- Service B uses the API signature provided by A

Semantics of A

- Data: Semantics of data created by A should be consistent with the assumption made by B
- Service: Same …..

Sequence

- Data -- data packets created by A should maintain the order as understood by B
- Control– A must execute 5ms before B. Or an API of A can be called only after calling another API

Interface identity

- Handle of A must be consistent with B, if A maintains multiple interfaces

Location of A

- B may assume that A is in-process or in a different process, hardware..

Quality of service/data provided by A

- Data quality produced by A must be > some accuracy for B to work

Existence of A

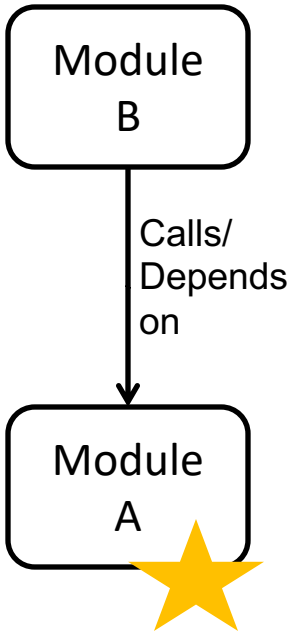
- B may assume that A must exist when B is calling A

Resource behavior of A

- B may assume that both use same memory
- B needs to reserve a resource owned by A

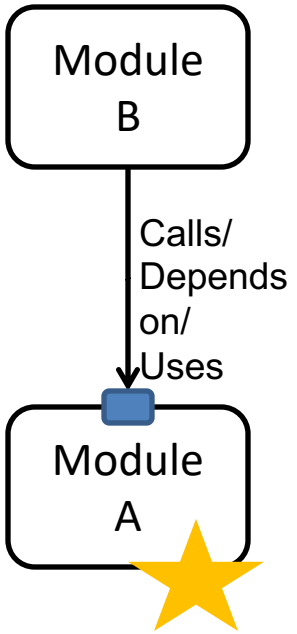
Localize Modifications

1. Factoring common service
   - Common services through a specialized module (only implementing module should be impacted)
     - Heavily used in application framework and middleware
   - Reduce Coupling and increase cohesion
2. Anticipate Expected Changes
   - Quite difficult to anticipate, hence should be coupled with previous one
   - Allow extension points to accommodate changes
3. Generalize the Module
   - Allowing it to perform broader range of functions
   - Externalize configuration parameters (could be described in a language like XML)
     - The module reconfigure itself based on the configurable parameters
   - Externalize business rules
4. Limit Possible options
   - Do not keep too many options for modules that are part of the framework



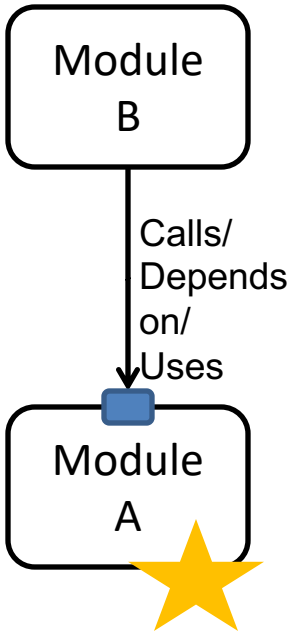
Prevent Ripple Effect Tactics

1. Hide Information (of A)
   - Use interfaces, allow published API based calls only
2. Maintain existing Interface (of A)
   - Add new interfaces if needed
   - Use Wrapper, adapter to maintain same interface
   - Use stub
3. Restrict Communication Paths
   - Too many modules should not depend on A
4. Use an intermediary between B and A
   - Data
     - Repository from which B can read data created by A (blackboard pattern)
     - Publish-subscribe (data flowing through a central hub)
     - MVC pattern
   - Service: Use of design patterns like bridge, mediator, strategy, proxy
   - Identity of A – Use broker pattern which deals with A's identity
   - Location of A – Use naming service to discover A
   - Existence of A- Use factory pattern



Defer Binding Time

1. Runtime registration of A (plug n play)
   - Use of pub-sub
2. Configuration Files
   - To take decisions during startup
3. Polymorphism
   - Late binding of method call
4. Component Replacement (for A)
   - during load time such as classloader
5. Adherence to a defined protocol- runtime binding of independent processes



Design Checklist- Modifiability

- Allocation of Responsibilities
  - Determine the types of changes that can come due to technical, customer or business
  - Determine what sort of additional features are required to handle the change
  - Determine which existing features are impacted by the change
- Coordination Model
  - For those where modifiability is a concern, use techniques to reduce coupling
    - Use publish-subscribe, use enterprise service bus
  - Identify
    - which features can change at runtime
    - which devices, communication paths or protocols can change at runtime
  - And make sure that such changes have limited impact on the system

Design checklist- Modifiability

- Data Model
  - For the anticipated changes, decide which data elements will be impacted, and the nature of impact (creation, modification, deletion, persistence, translation)
  - Group data elements that are likely to change together
  - Design to ensure that changes have minimal impact to the rest of the system
- Resource Management
  - Determine how addition, deletion or modification of a feature or a quality attribute cause
    - New resources to be used, or affect resource usage
    - Changing of resource usage limits
  - Ensure that the resources after modification are sufficient to meet the system requirement
  - Write Resource manager module that encapsulates resource usage policies

Design Checklist- Modifiability

- Binding
  - Determine the latest time at which the anticipated change is required
  - Choose a defer binding if possible
  - Try to avoid too many binding choices
- Choice of Technology
  - Evaluate the technology that can handle modifications with least impact (e.g. enterprise service bus)
  - Watch for vendor lock-in

SS ZG653 (RL 5.2): Software Architecture

Performance and Its Tactics

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What is Performance?

- Software system's ability to meet timing requirements when it responds to an event
- Events are
  - interrupts, messages, requests from users or other systems
  - clock events marking the passage of time
- The system, or some element of the system, must **respond to them** in time

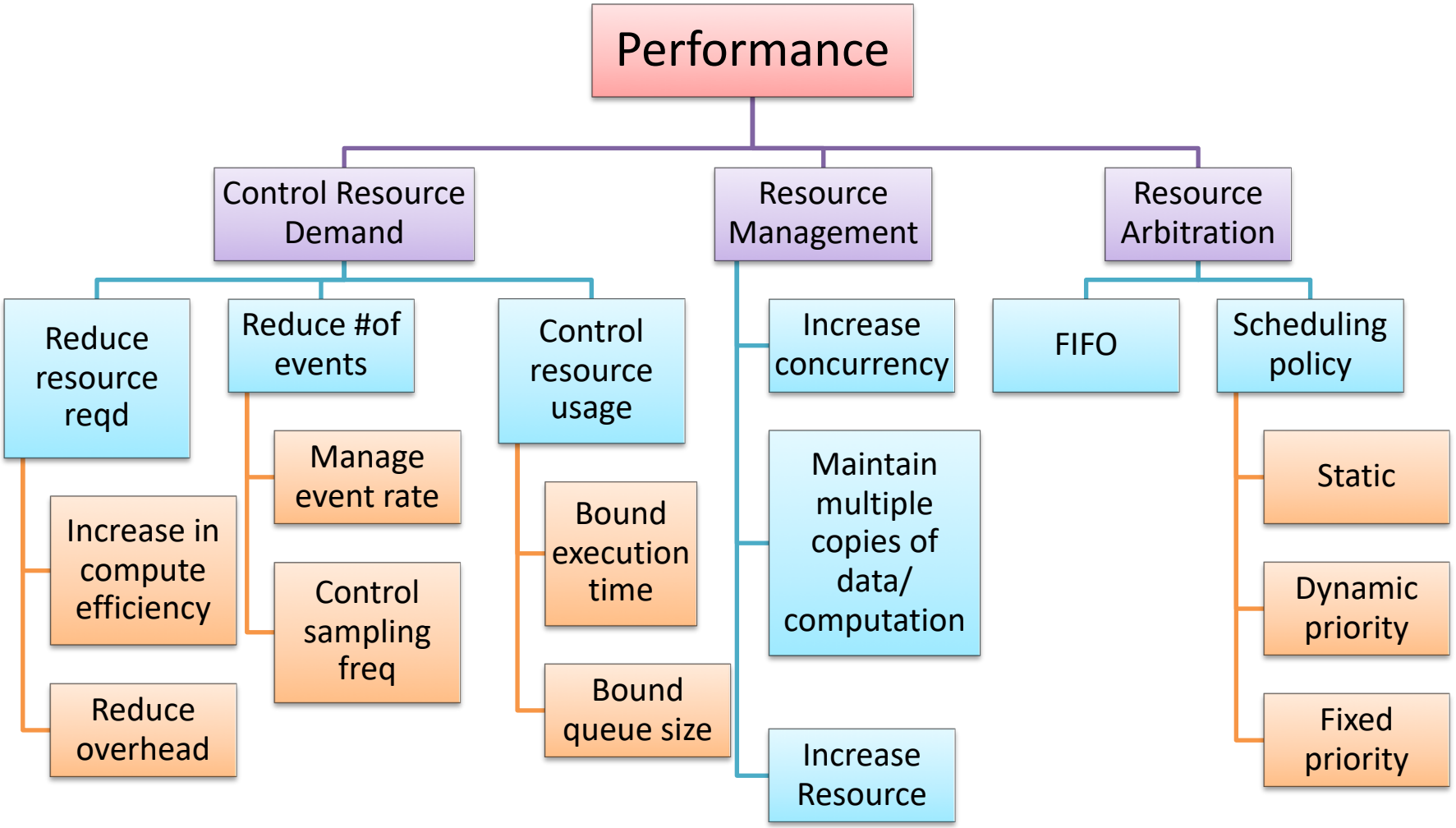
Performance Scenarios

WHO	STIMULUS	IMPACTED PART	MITIGATING ACTION	MEASURABLE RESPONSE
• External • Internal	•**Events that are** •Periodic •Sporadic •Stochastic (with avg 1000 txn/min)	System •Running in normal mode •Overloaded	✓ Processes event in time ✓ Changes the service-level	• Latency or deadline by which it must be processed • Throughput- #of events processed/time • Jitter- variation • Miss rate • Data loss
Users	Submits transactions and expect response in 3s		Transactions processed	Average latency of 2s

Events and Responses

- Periodic- comes at regular intervals (real time systems)
- Stochastic- comes randomly following a probability distribution (eCommerce website)
- Sporadic- keyboard event from human
- Latency- time between arrival of stimulus and system response
- Throughput- number of txn processed/unit of time
- Jitter- allowable variation in latency
- #events not processed

Performance Tactics



Why System fails to Respond?

- Resource Consumption
  - CPU, memory, data store, network communication
  - A buffer may be sequentially accessed in a critical section
  - There may be a workflow of tasks one of which may be choked with request

- Blocking of computation time
  - Resource contention
  - Availability of a resource
  - Deadlock due to dependency of resource

Control Resource Demand

- Increase Computation Efficiency: Improving the algorithms used in performance critical areas
- Reduce Overhead
  - Reduce resource consumption when not needed
    - Use of local objects instead of RMI calls
    - Local interface in EJB 3.0
  - Remove intermediaries (conflicts with modifiability)
- Manage
  - event rate: If you have control, don't sample too many events (e.g. sampling environmental data)
  - sampling time: If you don't have control, sample them at a lower speed, leading to loss of request
- Bound
  - Execution: Decide how much time should be given on an event. E.g. iteration bound on a data-dependent algorithm
  - Queue size: Controls maximum number of queued arrivals

Manage Resources

- Increase Resources(infrastructure)
  - Faster processors, additional processors, additional memory, and faster networks
- Increase Concurrency
  - If possible, process requests in parallel
  - Process different streams of events on different threads
  - Create additional threads to process different sets of activities
- Multiple copies
  - Computations : so that it can be performed faster (client-server), MapReduce computation
  - Data:
    - use of cache for faster access and reduce contention
    - Hadoop maintains data copies to avoid data-transfer and improve data locality

Resource Arbitration

- Resources are scheduled to reduce contention
  - Processors, buffer, network
  - Architect needs to choose the right scheduling strategy
- FIFO
- Fixed Priority
  - Semantic importance
    - Domain specific logic such as request from a privileged class gets higher priority
  - Deadline monotonic (shortest job first)
- Dynamic priority
  - Round robin
  - Earliest deadline first- the job which has earliest deadline to complete
- Static scheduling
  - Also pre-emptive scheduling policy

Design Checklist for a Quality Attribute

- Allocate responsibility
  - Modules can take care of the required quality requirement
- Manage Data
  - Identify the portion of the data that needs to be managed for this quality attribute
  - Plan for various data design w.r.t. the quality attribute
- Resource Management Planning
  - How infrastructure should be monitored, tuned, deployed to address the quality concern
- Manage Coordination
  - Plan how system elements communicate and coordinate
- Binding

Performance- Design Checklist- Allocate responsibilities

- Identify which features may involve or cause
  - Heavy workload
  - Time-critical response
- Identify which part of the system that's heavily used
- For these, analyze the scenarios that can result in performance bottleneck
- Furthermore--
  - Assign Responsibilities related to threads of control —allocation and de-allocation of threads, maintaining thread pools, and so forth
  - Assign responsibilities that will schedule shared resources or appropriately select, manage performance-related artifacts such as queues, buffers, and caches

Performance- Design Checklist- Manage Data

- Identify the data that's involved in time critical response requirements, heavily used, massive size that needs to be loaded etc. For those data determine
  - whether maintaining multiple copies of key data would benefit performance
  - partitioning data would benefit performance
  - whether reducing the processing requirements for the creation, initialization, persistence, manipulation, translation, or destruction of the enumerated data abstractions is possible
  - whether adding resources to reduce bottlenecks for the creation, initialization, persistence, manipulation, translation, or destruction of the enumerated data abstractions is feasible.

Performance- Design Checklist- Manage Coordination

- Look for the possibility of introducing concurrency (and obviously pay attention to thread-safety), event priorization, or scheduling strategy
  - Will this strategy have a significant positive effect on performance? Check
  - Determine whether the choice of threads of control and their associated responsibilities introduces bottlenecks

- Consider appropriate mechanisms for example
  - stateful, stateless, synchronous, asynchronous, guaranteed delivery

Performance Design Checklist- Resource Management

- Determine which resources (CPU, memory) in your system are critical for performance.
  - Ensure they will be monitored and managed under normal and overloaded system operation.
- Plan for mitigating actions early, for instance
  - Where heavy network loading will occur, determine whether co-locating some components will reduce loading and improve overall efficiency.
  - Ensure that components with heavy computation requirements are assigned to processors with the most processing capacity.

- Prioritization of resources and access to resources
  - scheduling and locking strategies
- Deploying additional resources on demand to meet increased loads
  - Typically possible in a Cloud and virtualized scenario

Performance Design checklist-Binding

- For each element that will be bound after compile time, determine the
  - time necessary to complete the binding
  - additional overhead introduced by using the late binding mechanism

- Ensure that these values do not pose unacceptable performance penalties on the system.

Performance Design Checklist- Technology choice

- Choice of technology is often governed by the organization mandate (enterprise architecture)
- Find out if the chosen technology will let you set and meet real time deadlines?
  - Do you know its characteristics under load and its limits?
- Does your choice of technology give you the ability to set
  - scheduling policy
  - Priorities
  - policies for reducing demand
  - allocation of portions of the technology to processors
- Does your choice of technology introduce excessive overhead?

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Thank You