Architectural Tactics

CS6.401 Software Engineering

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Acknowledgements

The materials used in this presentation have been gathered/adapted/generate from various sources as well as based on my own experiences and knowledge -- Karthik Vaidhyanathan

Sources:

1. Software Architecture in Practice, Len Bass, 2nd, 3rd edition

System Qualities

1. Availability
2. Security
3. Performance
4. Modifiability
5. Testability
6. Usability
7. Sustainability

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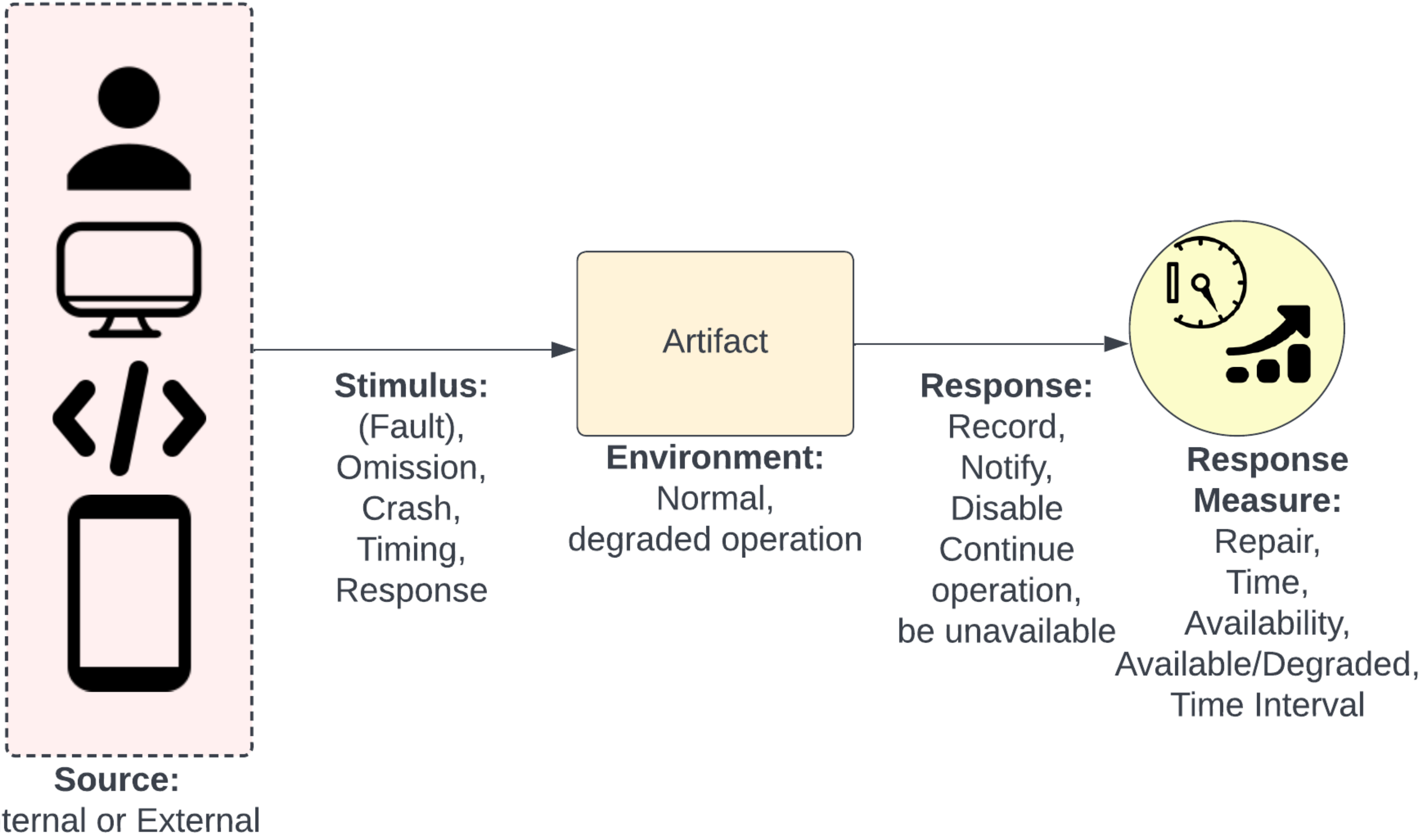
Quality Scenarios - General



Source:
Internal or External

Stimulus:
(Fault),
Omission,
Crash,
Timing,
Response

Artifact

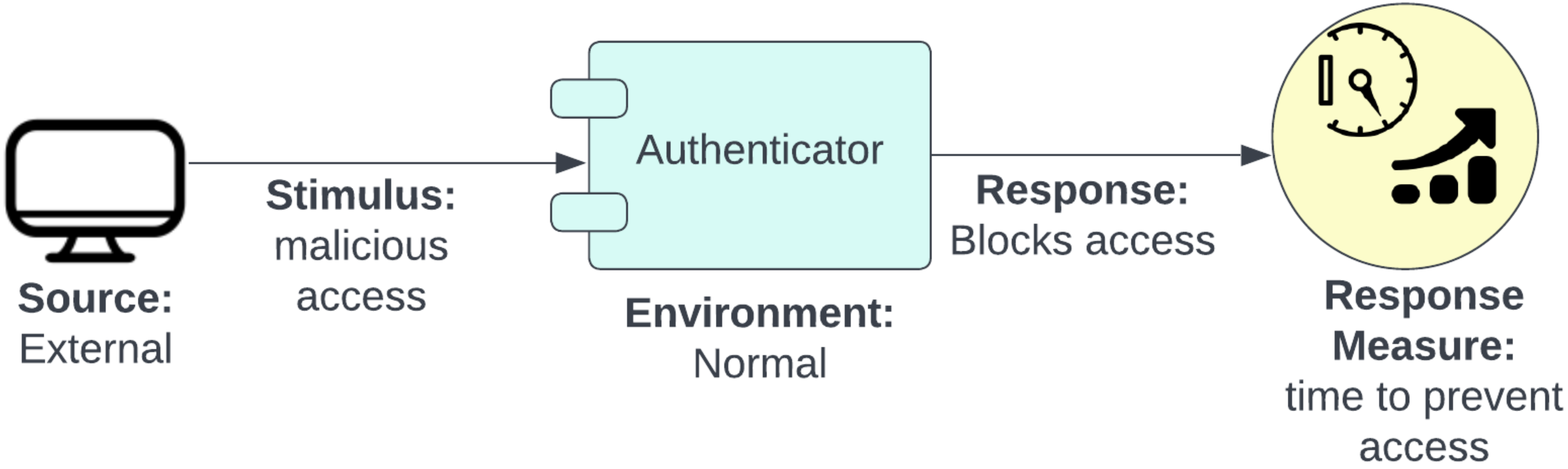
Environment:
Normal,
degraded operation

Response:
Record,
Notify,
Disable
Continue
operation,
be unavailable

Response Measure:
Repair,
Time,
Availability,
Available/Degraded,
Time Interval

Source: Googe images

Quality Scenarios - Concrete



Source: External

Stimulus: malicious access

Authenticator

Environment: Normal

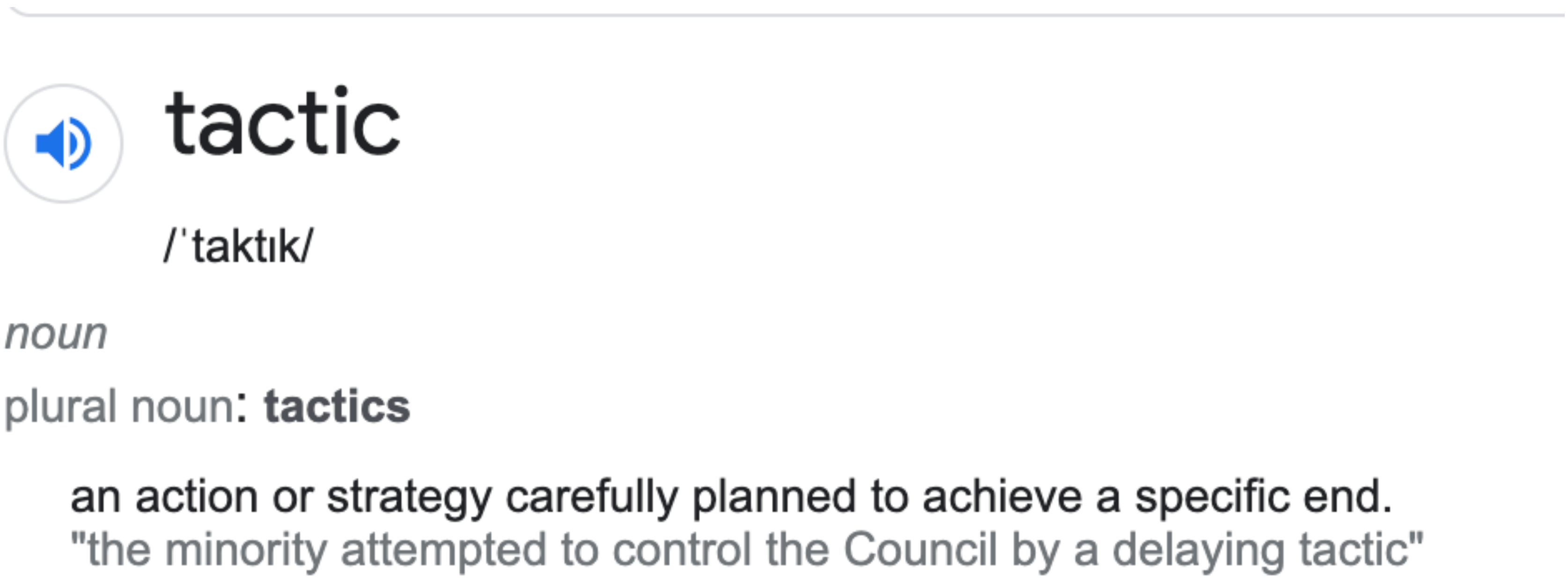
Response: Blocks access

Response Measure: time to prevent access

Source: Googe images

Architectural Tactics

What is Tactic?



tactic

/ˈtaktɪk/

noun

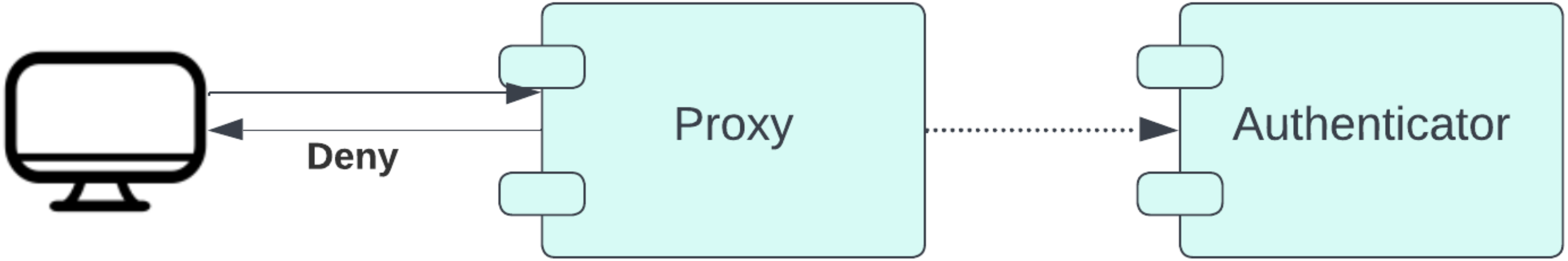
plural noun: **tactics**

an action or strategy carefully planned to achieve a specific end.

"the minority attempted to control the Council by a delaying tactic"

What about Architectural Tactics?

“Characterization of architectural decisions that are used to achieve a desired quality attribute response”



Availability

Availability

Software is ready to carry out a task when you need it to be

1. Concerned with system failures and associated consequences
2. Failure and fault are two different yet related things
3. Mean time to failure and mean time to repair
4. Scheduled downtimes

Availability %	Downtime per year
90% (one nine)	36.5 days
99% (two nines)	3.65 days
99.9% (three nines)	8.46 ~~days~~
99.99% (four nines)	52.34 minutes
99.999% (five nines)	5.26 minutes
99.9999% (six nines)	32 seconds

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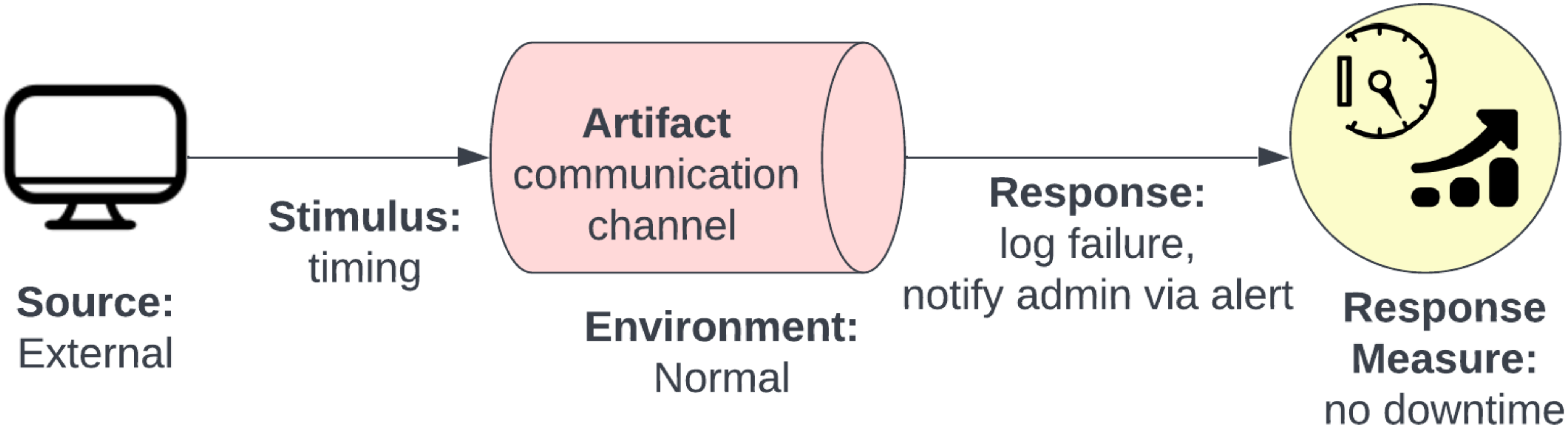
Availability Scenario Example

Scenario: user app fails to receive an acknowledgement from the museum booking service



Source: External

Stimulus: timing

Artifact communication channel

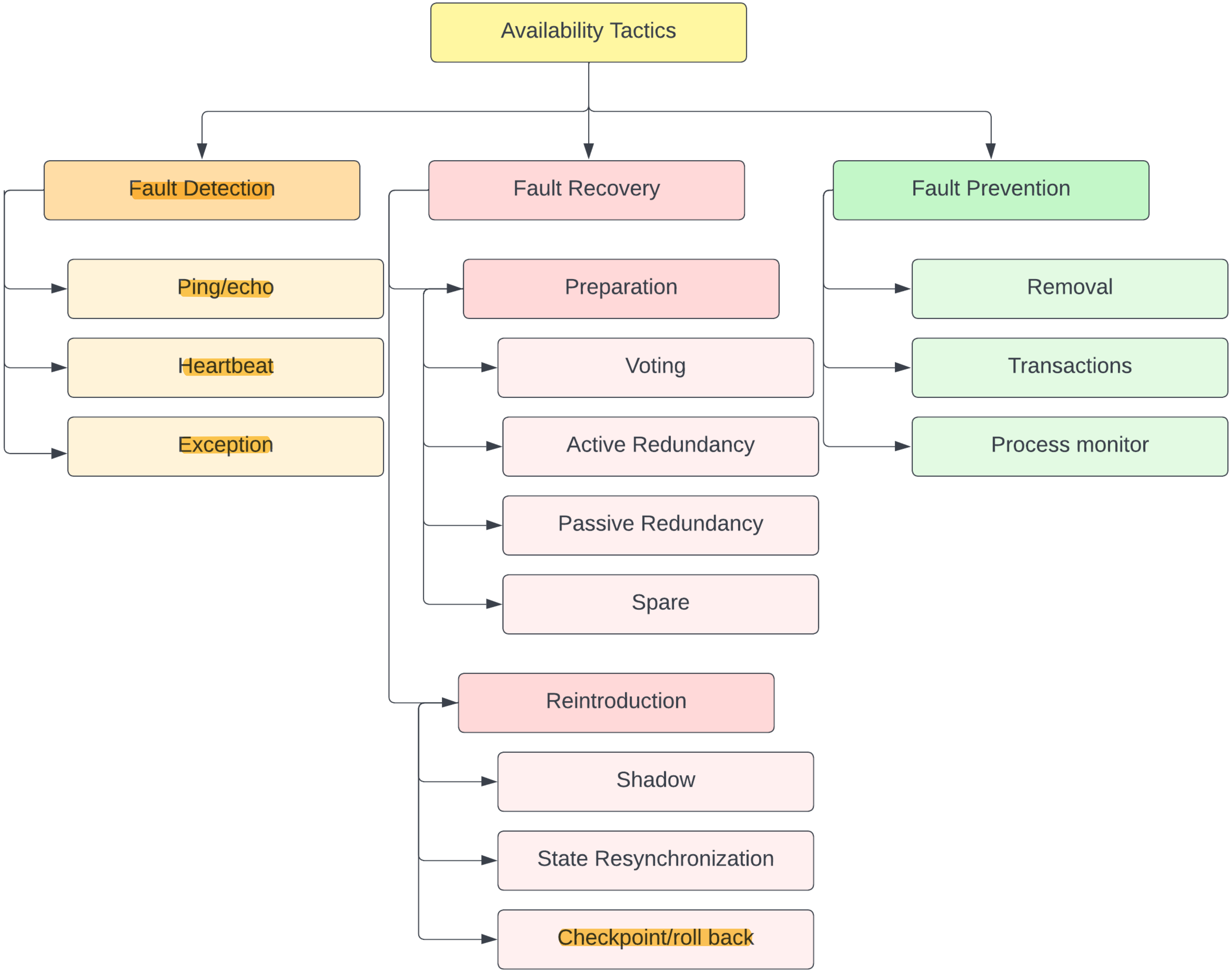
Environment: Normal

Response: log failure, notify admin via alert

Response Measure: no downtime

Availability Scenarios Table

Name	Classes
Source of Stimulus	Internal and external
Stimulus	Type of fault (ommission, crash, timing, response)
Artifact	Processors, channels, storage
Environment	Normal or degraded mode
Response	Logging, notification, switching to backup, restart, shutdown
Response measure	Availability time, uptime, repair time



- Availability Tactics
  - Fault Detection
    - Ping/echo
    - Heartbeat
    - Exception
  - Fault Recovery
    - Preparation
      - Voting
      - Active Redundancy
      - Passive Redundancy
      - Spare
    - Reintroduction
      - Shadow
      - State Resynchronization
      - Checkpoint/roll back
  - Fault Prevention
    - Removal
    - Transactions
    - Process monitor

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Performance

Performance

Performance is about timing. Events occur and system must respond to them

Event arrival patterns

1. Periodic
2. Stochastic
3. Sporadic

Event Servicing

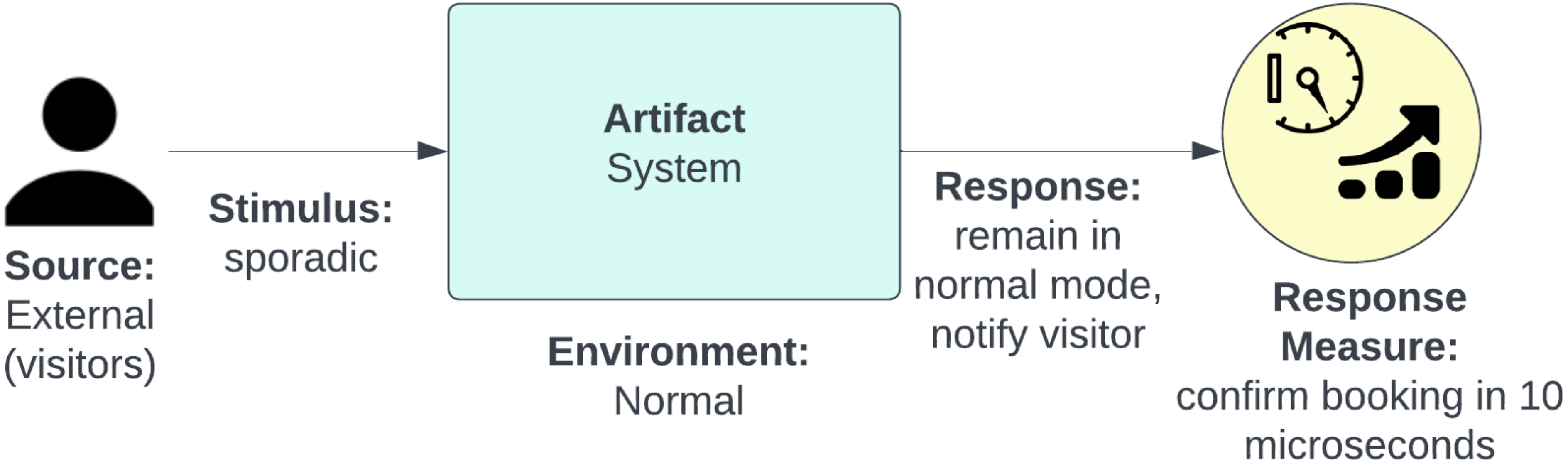
1. Latency - Time taken between arrival and response
2. Jitter – Variation in latency
3. Throughput – Number of requests processed per second

Performance Scenarios Table

Name	Classes
Source of Stimulus	Internal and external
Stimulus	Event arrival (based on pattern)
Artifact	System
Environment	Normal mode; Overload mode
Response	Changes level of service, processes stimuli
Response measure	Latency, throughput, jitter, miss rate, data loss

Performance Scenario Example

Scenario: Visitor needs to get notified as soon as booking is made



Source: External (visitors)

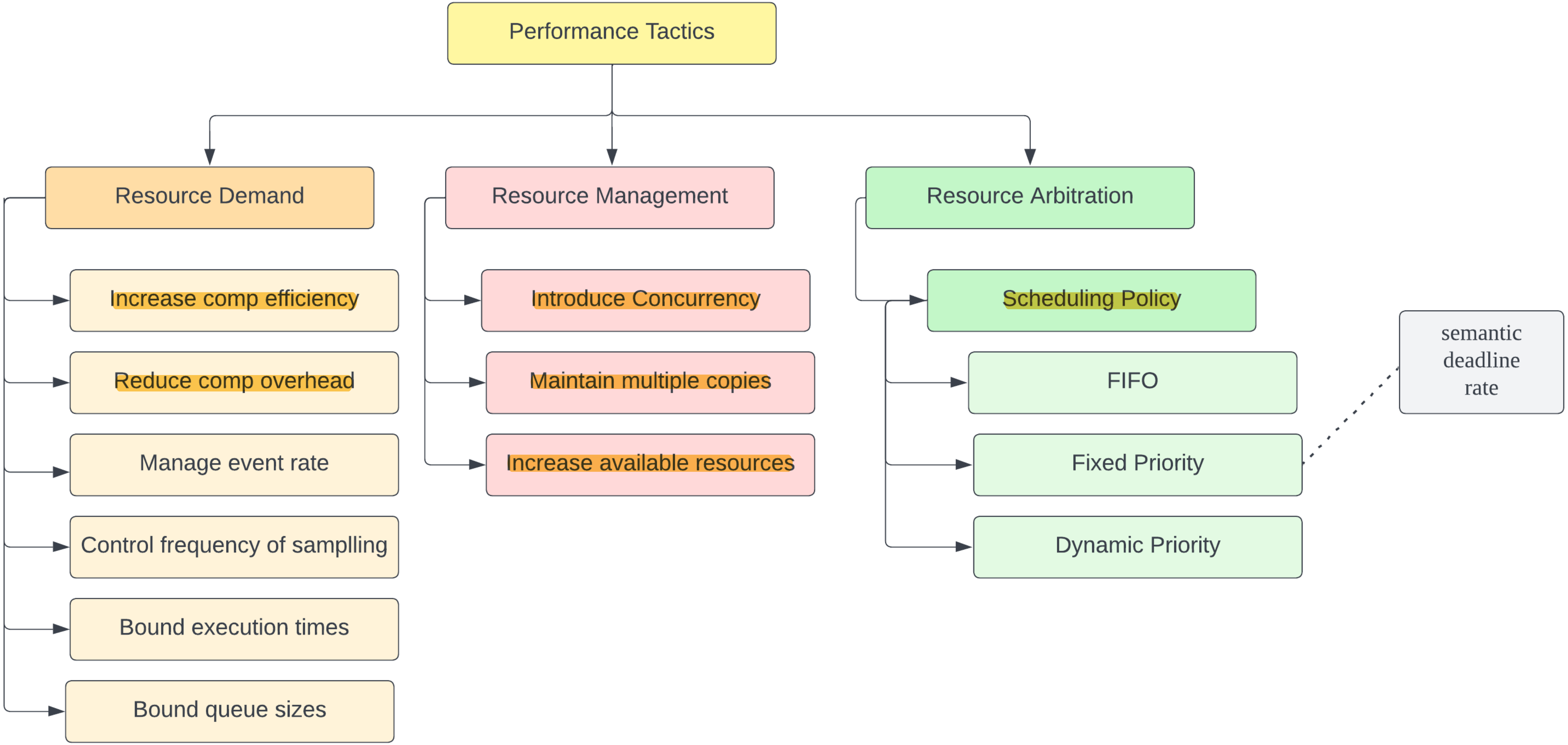
Stimulus: sporadic

Artifact System

Environment: Normal

Response: remain in normal mode, notify visitor

Response Measure: confirm booking in 10 microseconds



Performance Tactics

- Resource Demand
  - Increase comp efficiency
  - Reduce comp overhead
  - Manage event rate
  - Control frequency of samplling
  - Bound execution times
  - Bound queue sizes
- Resource Management
  - Introduce Concurrency
  - Maintain multiple copies
  - Increase available resources
- Resource Arbitration
  - Scheduling Policy
    - FIFO
    - Fixed Priority
      - semantic deadline rate
    - Dynamic Priority

Security

Security

Measure of system’s ability to resist unauthorized usage while still providing services to legitimate users

System providing:

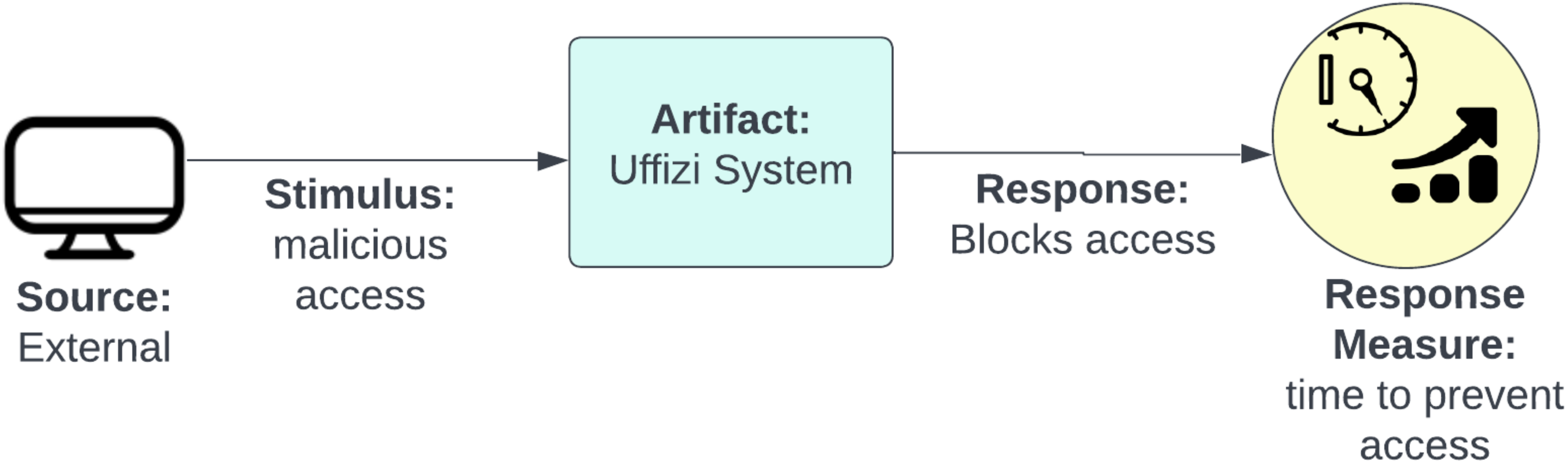
1. Confidentiality
2. Integrity
3. Availability
4. Non-repudiation
5. Assurance
6. Auditing

Security Scenarios Table

Name	Classes
Source of Stimulus	User, system, unidentified
Stimulus	Tries to Change/modify data, access system services
Artifact	System services, data within
Environment	Open, firewalled, online, offline
Response	Logging, block access, notify
Response measure	Probability of detection, recovery

Security Scenario Example

Scenario: Hackers are prevented from disabling the system



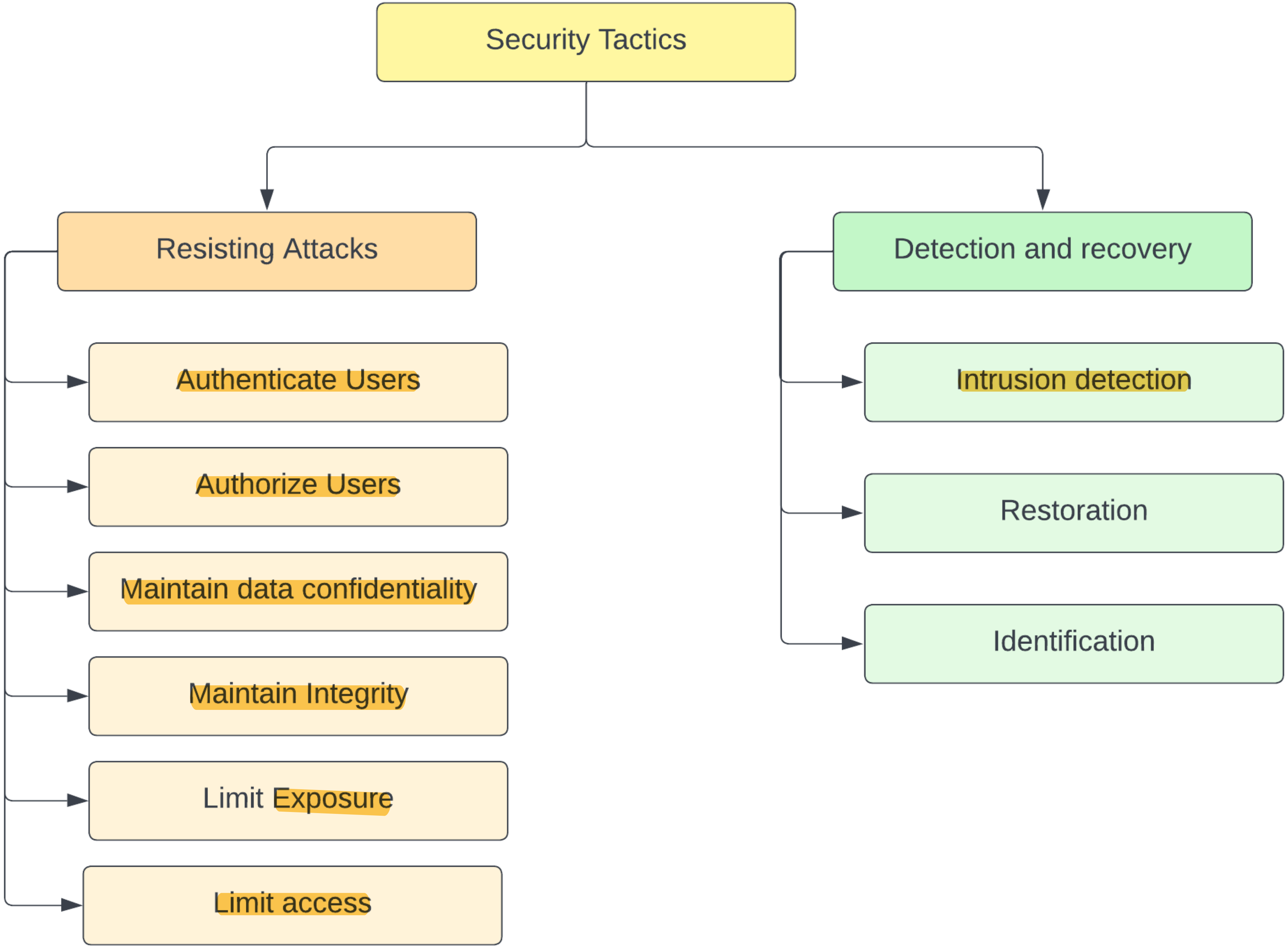
Source: External

Stimulus: malicious access

Artifact: Uffizi System

Response: Blocks access

Response Measure: time to prevent access



- Security Tactics
  - Resisting Attacks
    - Authenticate Users
    - Authorize Users
    - Maintain data confidentiality
    - Maintain Integrity
    - Limit Exposure
    - Limit access
  - Detection and recovery
    - Intrusion detection
    - Restoration
    - Identification

Modifiability

Modifiability

Modifiability is about the cost of change. It brings in few concerns:

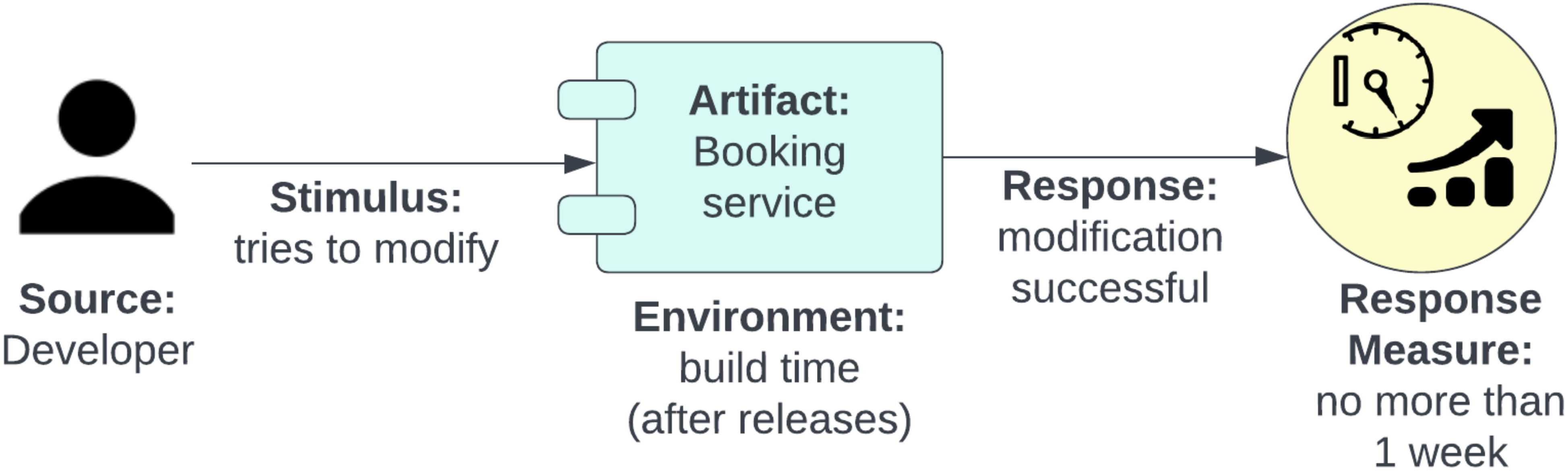
1. What can change (the artifact) ?
2. When is the change made ?
3. Who makes it (the environment) ?

Modifiability Scenarios Table

Name	Classes
Source of Stimulus	Developer, admin, user
Stimulus	Add/modify function
Artifact	UI, Platform, environment
Environment	Runtime, compile time, build time, design time
Response	Make changes and verify
Response measure	Effort, time, cost

Modifiability Scenario Example

Scenario: Developer wants to change booking service



Source: Developer

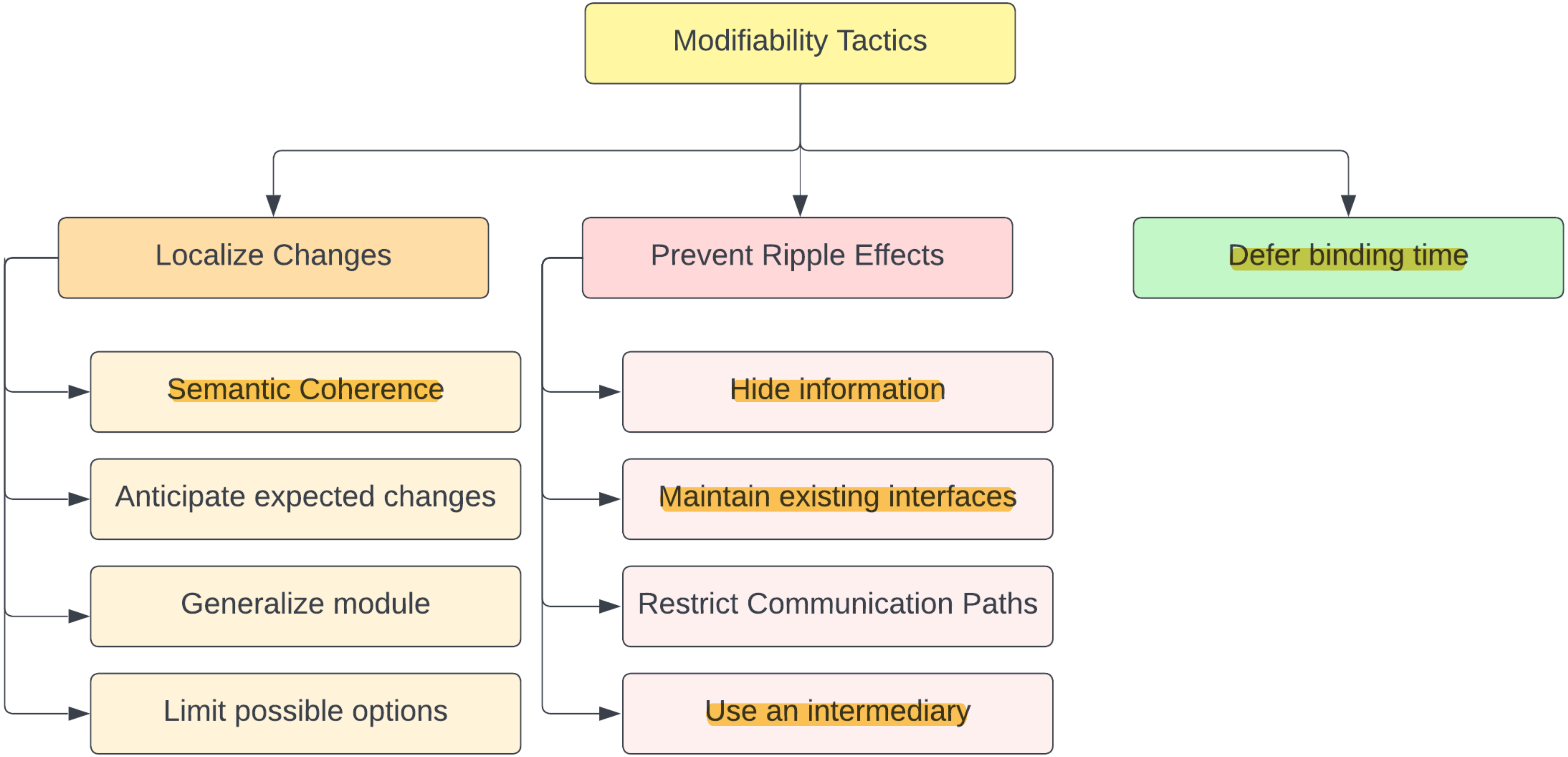
Stimulus: tries to modify

Artifact: Booking service

Environment: build time (after releases)

Response: modification successful

Response Measure: no more than 1 week



Modifiability Tactics

- Localize Changes
  - Semantic Coherence
  - Anticipate expected changes
  - Generalize module
  - Limit possible options
- Prevent Ripple Effects
  - Hide information
  - Maintain existing interfaces
  - Restrict Communication Paths
  - Use an intermediary
- Defer binding time

Testability

Testability

Ease with which the software can be made to demonstrate its faults

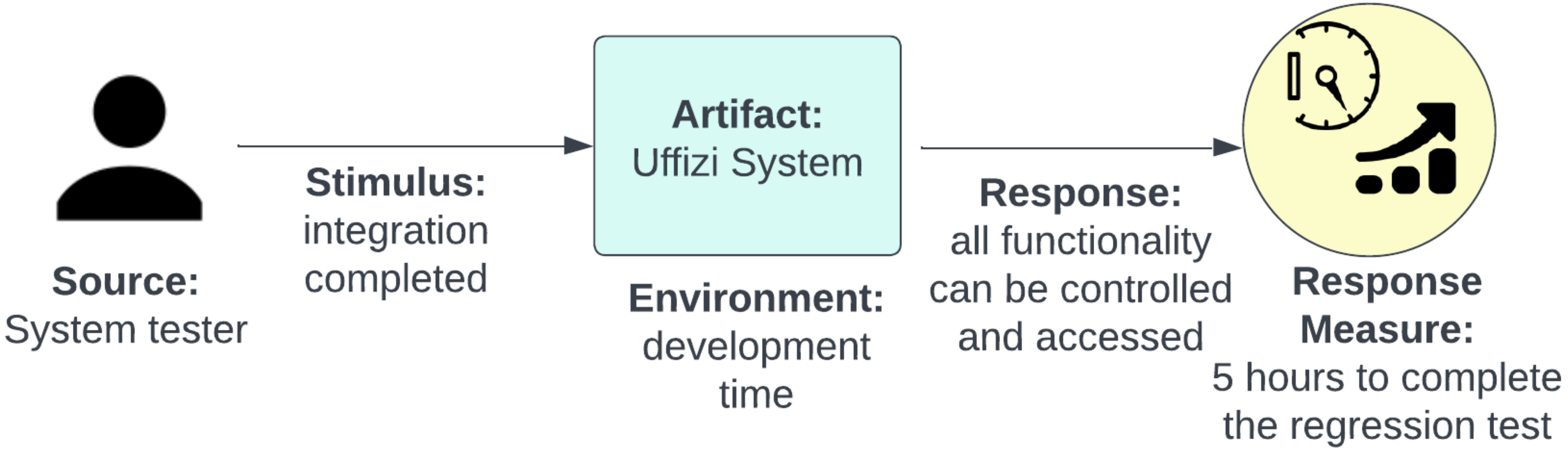
1. Probability of fault discovery
2. Need to control components
3. Component failures should be observable

Testability Scenarios Table

Name	Classes
Source of Stimulus	Developer, tester, user
Stimulus	Milestone completed
Artifact	Design, piece of code, component, system
Environment	Design, development, at compile deployment, run
Response	State values, computes test values
Response measure	Coverage, probability, time, length of longest dependancy

Testability Scenario Example

Scenario: New version of the system can be tested quickly



Source: System tester

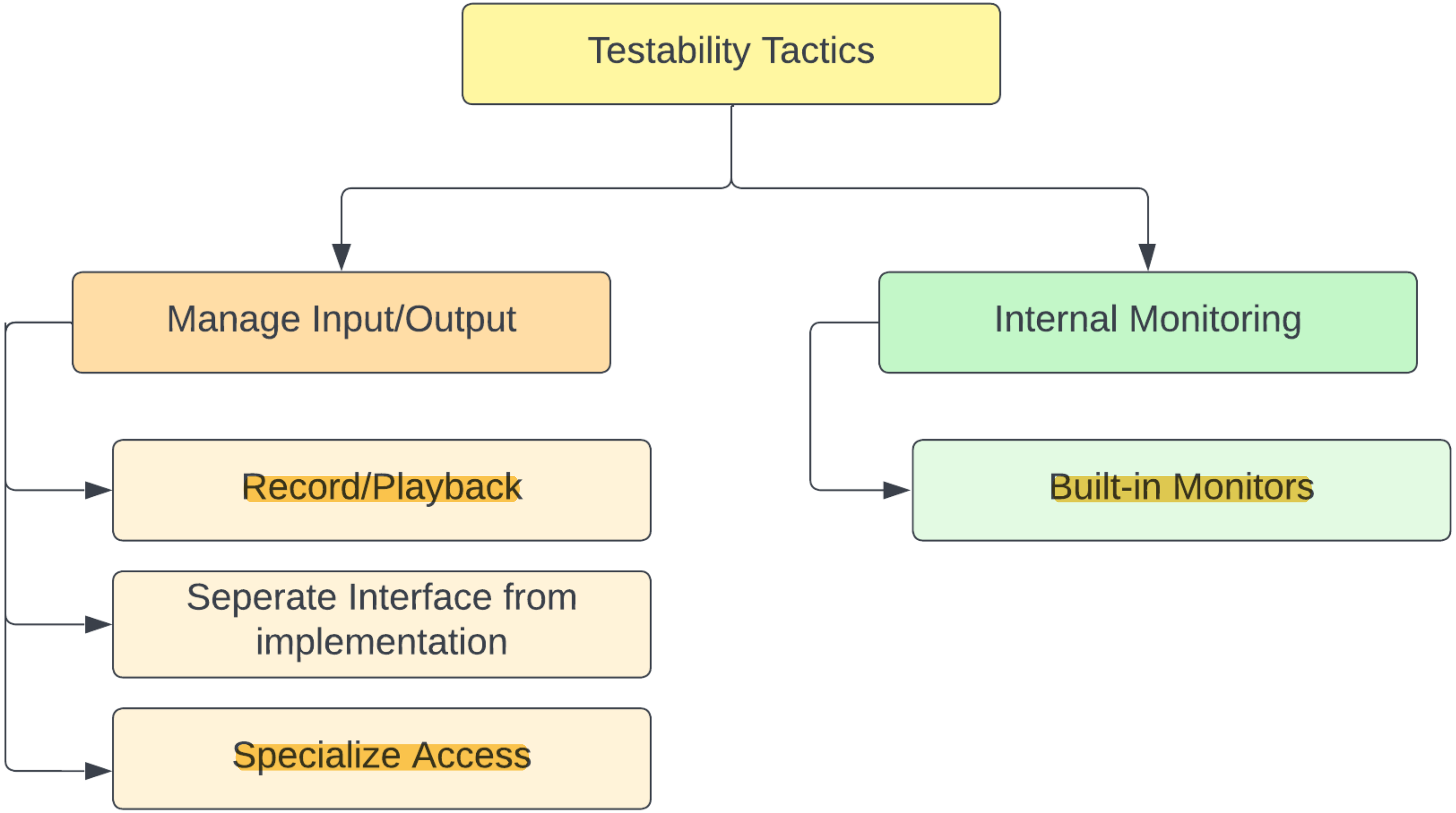
Stimulus: integration completed

Artifact: Uffizi System

Environment: development time

Response: all functionality can be controlled and accessed

Response Measure: 5 hours to complete the regression test



Testability Tactics

Manage Input/Output

- Record/Playback
- Seperate Interface from implementation
- Specialize Access

Internal Monitoring

- Built-in Monitors

Usability

Usability

How easy it is for user to accomplish a desired task and the kind of support the system provides

1. Learning system features
2. Using a system efficiently
3. Minimizing the impact of user errors
4. Adapting system to user needs
5. Increasing confidence and satisfaction

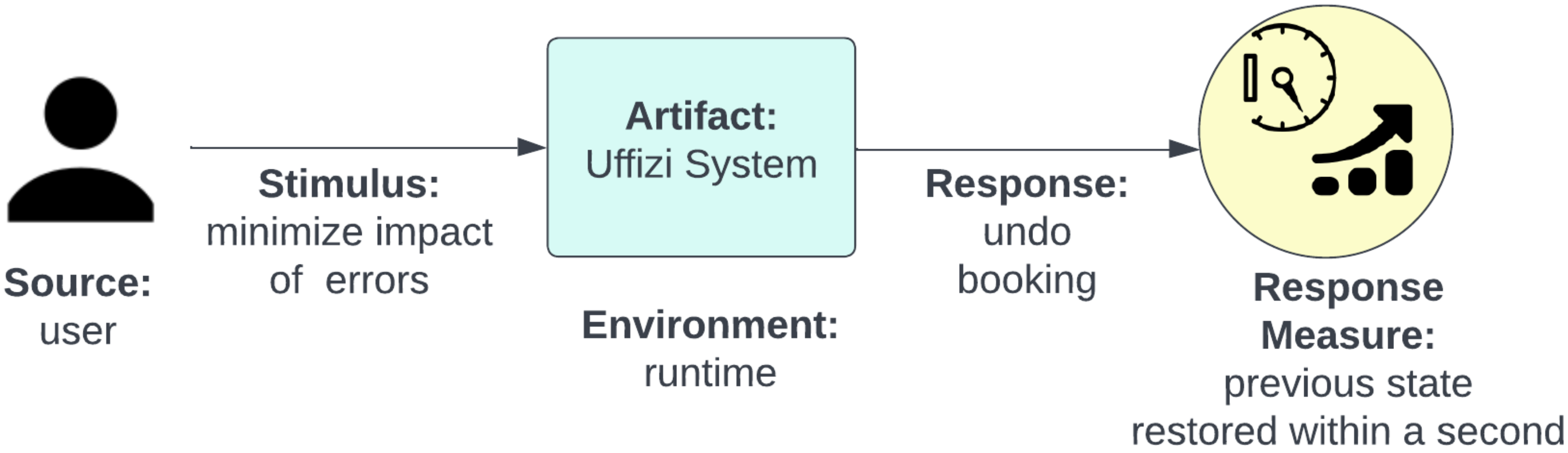
Usability has a strong corelation with modifiability

Usability Scenarios Table

Name	Classes
Source of Stimulus	End user
Stimulus	Learn the system, use efficiently, feel comfortable, minimize errors
Artifact	system
Environment	Configuration time or run time
Response	Provide users with required features, feedback to user, anticipate user needs
Response measure	Task time, number of errors, number of tasks accomplished, user satisfaction

Usability Scenario Example

Scenario: User may want to cancel during booking process



Source: user

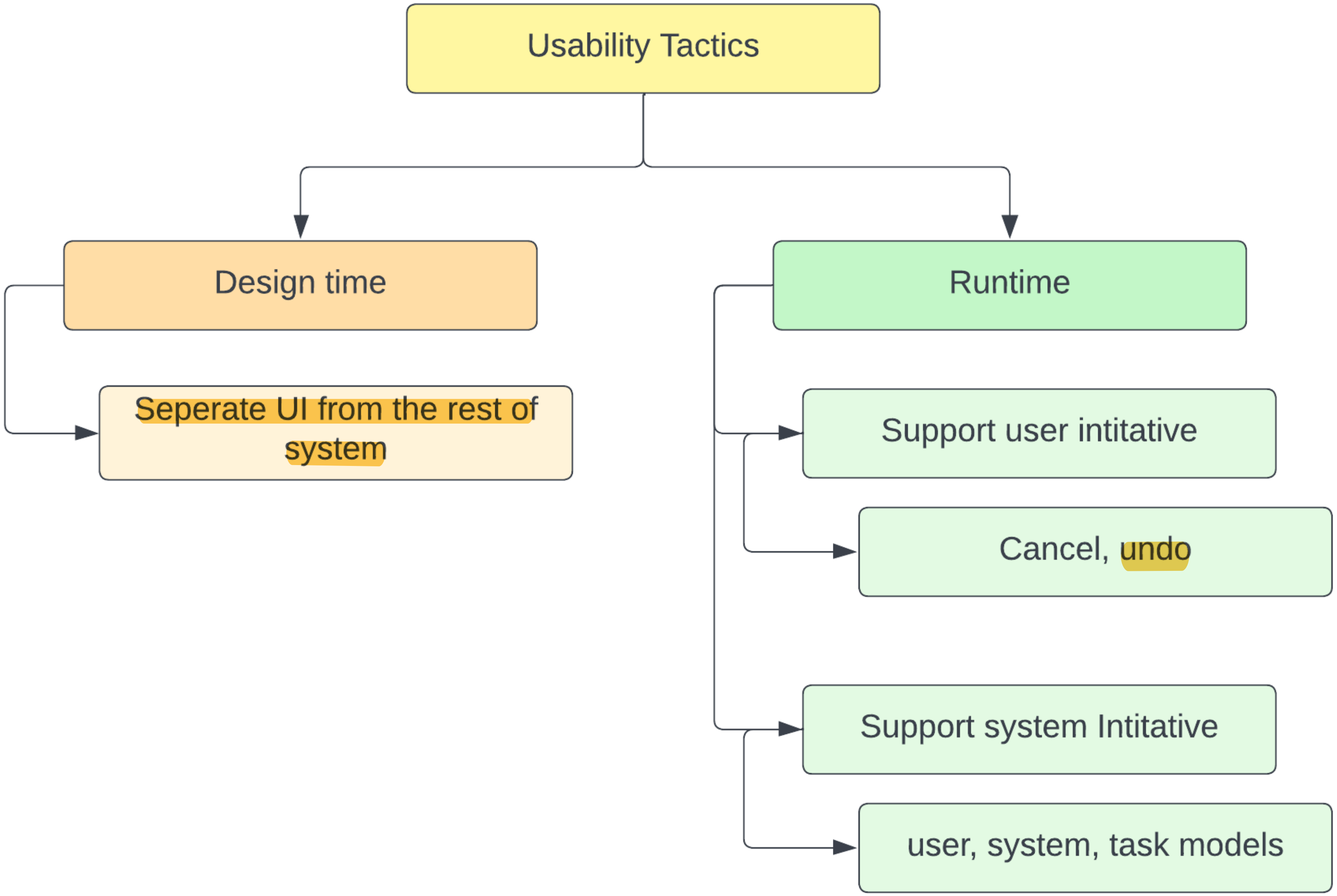
Stimulus: minimize impact of errors

Artifact: Uffizi System

Environment: runtime

Response: undo booking

Response Measure: previous state restored within a second



Usability Tactics

- Design time
  - Seperate UI from the rest of system
- Runtime
  - Support user intitative
    - Cancel, undo
  - Support system Intitative
    - user, system, task models

Thank You

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