Lecture 04:
Non Functional Requirements (NFR) – Quality Attributes

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Adapted from Ahmed E. Hassan and Ian Gorton
Last Class - Recap

- Lot of ambiguity within stakeholders
- Focus on the needs, not wants
- Specifications used to bridge gap between stakeholder demands and software system
- Use system perspective diagram to isolate system from users and interfaces
What are Quality Attributes

■ Often know as –ilities
  – Reliability
  – Availability
  – Portability
  – Scalability
  – Performance
ICDE System

Information Capture and Dissemination Environment (ICDE) is a software system for providing intelligent assistance to

- financial analysts
- scientific researchers
- intelligence analysts
- analysts in other domains
ICDE

- Automatically captures and stores data of actions performed by a user
- Google search:
  - Record query
  - List of returned pages
- Data can be later used by 3rd parties to offer intelligent help
ICDE Schematic

ICDE Repository

ICDE Recording Software

Internet

Local information repositories

Analyst

3rd Party Tools
## ICDE v2.0 Business Goals

<table>
<thead>
<tr>
<th>Business Goal</th>
<th>Supporting Technical Objective</th>
<th>Portability</th>
<th>Integration</th>
<th>Reliability</th>
<th>Scalability</th>
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<tbody>
<tr>
<td>Encourage third party tool developers</td>
<td>Simple and reliable programmatic access to data store for third party tools</td>
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<td>Heterogeneous (i.e. non-Windows) platform support for running third party tools</td>
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<td>Allow third party tools to communicate with ICDE users from a remote machine</td>
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<td>Promote the ICDE concept to users</td>
<td>Scale the data collection and data store components to support up to 150 users at a single site</td>
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<td>Low-cost deployment for each ICDE user workstation</td>
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Quality Attribute Specification

Architects are often told:
- “My application must be fast/secure/scale”

Quality attributes must be precise/measurable for a given system design, e.g.
- “It must be possible to scale the deployment from an initial 100 geographically dispersed user desktops to 10,000 without an increase in effort/cost for installation and configuration.”
Performance

Different ways to measure performance:
  – Throughput
  – Response Time
  – Deadlines
Performance - Throughput

- Measure of the amount of work in unit time
  - Transactions per second
  - Messages per minute
Throughput Example

![Graph showing Throughput Example](image-url)
Throughput Considerations

■ Is required throughput:
  – Average? (Video streaming)
  – Peak? (Bidding)

■ Many system have low average but high peak throughput requirements
Performance - Response Time

- **Latency or delay** an application exhibits in processing a request
  
  - Often an important metric for users (Point-of-sales, stock trading)
Example Response Time

- E.g. 95% of responses in sub-4 seconds, and all within 10 seconds
Response Time Considerations

- Is required response time:
  - Guaranteed? (VOIP)
  - Average? (Search)
Performance - Deadlines

- ‘something must be completed before some specified time’

  - Payroll system must complete by 2am

  - Weekly accounting run must complete by 6am Monday
Something to watch for …

- What is a
  - Transaction?
  - Message?
  - Request?

- All are application specific measures.

- System must achieve 100 mps throughput
  - BAD!!

- System must achieve 100 mps peak throughput for PaymentReceived messages
  - GOOD!!!
ICDE Performance Issues

- **Response time:**
  - Overheads of trapping user events must be negligible to users

- **Solution for ICDE client:**
  - Decouple user event capture from storage using a queue

1. Trap user event
2. Write event to queue
3. Return to user thread
4. Read event from queue
5. Write event to ICDE database queue
Scalability

‘How well a solution to some problem will work when the size of the problem increases’

- Request Load
- Connections
- Data size
- Deployment
Scalability – Request Load

■ How does an 100 TPS application behave when simultaneous request load grows?

■ Ideal solution:
  – as the load increases, throughput remains constant (i.e. 100 tps), and response time per request increases only linearly (i.e. 10 seconds).
Scalability – Add more hardware

Scale-up:
Single application instance is executed on a multiprocessor machine
Scalability - reality

- Decrease in throughput and exponential increase in response time.
  
  - Increased load causes increased contention for resources such as CPU, network and memory.
  
  - Each request consumes some additional resource (buffer space, locks, and so on) in the application, and eventually these are exhausted.
Scalability - connections

- What happens if number of simultaneous connections to an application increases?
  - Each connection consumes a resource?
  - Exceed maximum number of connections?
Connections Example

- ISP wants to scale to 100,000 users
  - Each user connection spawned a new process for targeted ads
  - Virtual memory on each server exceeded at 2000 users
  - Tech crash, ISP out of business
Scalability – Data Size

- How does an application behave as the data it processes increases in size?
  - Chat application sees average message size double?
  - Database table size grows from 1 million to 20 million rows?
  - Image analysis algorithm processes images of 100MB instead of 1MB?
Scalability - Deployment

- How does effort to install/deploy an application increase as installation base grows?
  - Install new users?

- Solutions typically revolve around automatic download/installation
  - E.g. downloading applications from the Internet
Scalability thoughts

- Scalability often overlooked
  - Major cause of application failure
  - Hard to predict
  - Hard to test/validate
  - Reliance on proven designs and technologies is essential
Scalability for ICDE

- Should be capable of handling a peak load of 150 concurrent requests from ICDE clients.
  - Relatively easy to simulate user load to validate this
Next Class

- Monday, Sep. 19
- Modifiability
- Security
- Availability
- Integration