

Inf2: SEPP Lecture 23:  
Non-functional requirements  
Reliability, Availability and their Metrics

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## In lecture 4 (Requirements Engineering)

We introduced Non-functional requirements (NFRs)

## This lecture...

Bringing into discussion the importance of measuring NFRs as part of monitoring the quality of the software

- ▶ Classification of NFRs
- ▶ NFRs in the development process
- ▶ What makes useful metrics
- ▶ Reliability and its metrics
- ▶ Availability and its metrics
- ▶ Comparison of metrics for reliability and availability

# Classification of NFRs

Concern the whole system, not just the software.

- ▶ Ways the system needs to be related to other systems and versions of itself:  
flexibility, maintainability, reusability, portability
- ▶ Properties of the system in use  
(including things the system must not do or allow to be done)  
usability  
dependability (safety, reliability, availability, resilience, ...)  
efficiency (performance, resource usage, ...)  
security (integrity, confidentiality, availability, ...)  
scalability

## NFRs in the development process

Must be identified along with functional requirements – at the end is too late. (Requires special care in agile developments).

Often tied up with architectural decisions: hard to modify late. For example, if you choose the AppFuse framework for your system, you are locked into its security model.

*How much* of an NFR is needed? Often essential to

- ▶ *quantify* the requirement
- ▶ have a way to *measure* the system – “metrics”.

## Useful metrics should ideally be...

- ▶ Measurable – e.g. not someone's opinion of how complex something was
- ▶ Specified with a precision – i.e. a range in which measured values have to fall
- ▶ MEANINGFUL!! – there must be some reason to believe that numbers for the metric have something to do with something we care about!

# Reliability

**Reliability** is about how likely the system or its element would run without a failure for a given period of time under predefined conditions.

It is a key non-functional requirement in many systems. But how does one specify reliability?

Several ways – most appropriate depends on the nature of the system.

# POFOD

**Probability of failure on demand** is the probability that the system will fail when service is requested.

- ▶ Mainly useful for systems that provide emergency or safety services (meant to be rarely used).
  - ▶ E.g. the emergency shutdown in a nuclear power plant will never be used – but if it is, it shouldn't fail.

How to evaluate? Repeated tests in simulation. Expensive?



# ROCOF

**Rate of occurrence of failure** is the number per unit time of failures (unexpected behaviour). 'Time' may mean elapsed time, processing time, number of transactions, etc.

- ▶ Mainly used for systems providing regular service, where failure is significant.
  - ▶ E.g. banking systems.
    - ▶ VisaNet processes over  $10^9$  transactions/day. Failure rate is not published, but probably (much) less than  $10^{-5}$  failures/transaction.

# MTTF & MTBF

MTTF = Mean time to failure

MTBF = Mean time between failures

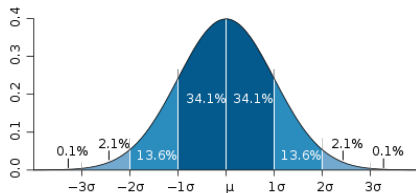
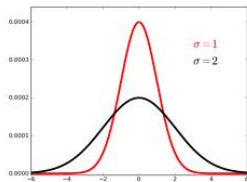
- ▶ Both mainly used where a single client uses the system for a long time.
- ▶ MTTF used when system is non-repairable.
  - ▶ Popular metric for hardware components.
- ▶ MTBF used when system can recover from failures.
  - ▶ E.g. used for OS crashes

Q: What's the difference between MTBF and ROCOF?

Q: You buy a hard drive with an MTTF of 5 years. When will you replace it?

# Statistics Digression

You know MTTF. Can you rely on that as an estimate?



# Availability

**Availability** is the proportion of the time that the system is 'available for use'. Often quoted as 'five nines', meaning 0.99999, 'four nines' etc.

Appropriate for systems offering a continuous service, where customers expect it to be there all the time. ('Five nines' is achieved by large data processing systems (e.g. VisaNet))

**Q:** What's the difference between availability and ROCOF?

## Comparison of metrics for reliability and availability

<b>Metric</b>	<b>Appropriate when...</b>	<b>Example</b>
POFOD	System is rarely used	Airliner oxygen masks
ROCOF	Regular service, failure significant	Online site, correct customer charge
MTTF MTBF	Single client, extended use	disks desktop OS crash
Availability	Continuous service	online site up

# Reading

**Recommended:** Sommerville SE Chapter 11 on Reliability Engineering, until section 11.3