NFR Catalog

TABLE I. NFR Classification

Non-functional Requirement	Type
Acceptability	Architectural NFR
Attention	Architectural NFR
Comprehensibility	Architectural NFR
Effectiveness	Architectural NFR
Elasticity	Architectural NFR
Environmental protection	Architectural NFR
Familiarity	Architectural NFR
Flexibility	Architectural NFR
Interconnectivity	Architectural NFR
Interoperability	Architectural NFR
Maintainability	Architectural NFR
Manageability	Architectural NFR
Modifiability	Architectural NFR
Multi-tenancy	Architectural NFR
Synchrony	Architectural NFR
Positioning of components	Architectural NFR
Predictability	Architectural NFR
Reusability	Architectural NFR
Scalability	Architectural NFR
Simplicity	Architectural NFR
Testability	Architectural NFR
Trust	Architectural NFR
Adaptation	Run-time NFR
Availability	Run-time NFR
Context-awareness	Run-time NFR
Calmness	Run-time NFR
Cost	Run-time NFR
Data Input/ Accuracy	Run-time NFR
Device Capability	Run-time NFR
Ease of use	Run-time NFR
User satisfaction	Run-time NFR
Utility	Run-time NFR
Efficiency	Run-time NFR
Energy Efficiency	Run-time NFR
Information display	Run-time NFR
Mobility	Run-time NFR
Network capability	Run-time NFR
Performance	Run-time NFR
Signal strength	Run-time NFR
Privacy	Run-time NFR
Reliability	Run-time NFR
Safety	Run-time NFR
Security	Run-time NFR
Robustness	Run-time NFR

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Non-functional Requirement	Type
Resiliance	Run-time NFR
RealTime Data Analysis	Run-time NFR
Invisibility	Run-time NFR

TABLE II. Run-time NFR Metrics Type

NFR	Metric Type
Availability	Quantitative
Cost	Quantitative
Data input/ accuracy	Quantitative
Device capability	Quantitative
Ease of use	Quantitative
Efficiency	Quantitative
Energy efficiency	Quantitative
Performance	Quantitative
Network capability	Quantitative
Signal strength	Quantitative
Reliability	Quantitative
Safety	Quantitative
Robustness	Quantitative
Privacy	Quantitative
Calmness	Qualitative
Mobility	Qualitative
Adaptations	Binary
Context-awareness	Metric Not Found
Utility	Metric Not Found
Information display	Metric Not Found
Security	Quantitative
Resiliance	Quantitative
Real-time data analysis	Metric Not Found
Invisibility	Metric Not Found

TABLE III. Run-time NFR Metrics

Non-functional Requirement	**Metric**
Adaptation	Element/ architecture/ software adaptability index
Availability	Probability percentage of system uptime
Calmness	Calm Timing (availability, context-sensitive timing), Calm Interaction (relevancy of interaction, courtesy of interaction)
Cost	Total cost of ownership (TCO) for acquisition, installation, use, disposal
Data Input/ accuracy	Accuracy of input processing
Device Capability	Resolution for camera, Range, frequency, low-light resolution, clock speed, memory size
Efficiency	Number of events processed/denied in some interval of time, throughput, capacity, usage ratio, maximum number of concurrent processes, memory utilization
Energy Efficiency	Energy consumption of different components can be expressed as constraints
Mobility	Can be expressed in terms of binding of components with respect to its environment scaling from strong to weak.
Network capability	Bandwidth requirement, permissible latency
Performance	Response time, space, capacity, throughput, speed (tasks completed/ unit time)
Privacy	Amount of information leak (privacy scores/ privacy quotient), sensitivity or visibility scores
Reliability	Mean time to failure, Probability of unavailability, Rate of failure occurrence
Safety	Speed, device temperature
Security	confidentiality, integrity, access control, authentication
Robustness	Time to recovery, % of incidents leading to catastrophic failures, Data corruption probability after a failure
Resiliance	Disruption Tolerance, recovery rapidity, performance loss

REFERENCES

[1] D. Mairiza, D. Zowghi, and V. Gervasi, "Conflict characterization and analysis of non functional requirements: An experimental approach," in *2013 IEEE 12th International Conference on Intelligent Software Methodologies, Tools and Techniques (SoMeT)*, 2013, pp. 83–91.

[2] R. M. Carvalho, R. M. C. Andrade, and K. M. de Oliveira, "Towards a catalog of conflicts for hci quality characteristics in ubicomp and iot applications: Process and first results," in *2018 12th International Conference on Research Challenges in Information Science (RCIS)*, 2018, pp. 1–6.

[3] K. E. Wiegers and J. Beatty, *Software Requirements*. Microsoft Press, 2013.

[4] L. Nogueira, A. Barros, C. Zubia, D. Faura, D. Gracia Pérez, and L. Miguel Pinho, "Non-functional requirements in the elastic architecture," vol. 40, no. 1, 2020. [Online]. Available: https://doi.org/10.1145/3431235.3431243

[5] P. Yu, X. Ma, J. Cao, and J. Lu, "Application mobility in pervasive computing: A survey," *Pervasive and Mobile Computing*, vol. 9, no. 1, pp. 2–17, 2013, special Section: Pervasive Sustainability. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1574119212000934

[6] X. Zhang and X. Wang, "Tradeoff analysis for conflicting software non-functional requirements," *IEEE Access*, vol. 7, pp. 156 463–156 475, 2019.

TABLE IV. NFR Conflict Catalog

Conflict Pair		
Non-functional Requirement	**Non-functional Requirement**	**Reference**
Cost	Availability	**Derived**
Cost	Device Capability	**Derived**
Cost	Data Input/ accuracy	**Derived**
Usability	Performance	**[1]**
Usability	Efficiency	**[2], [3]**
Usability	Security	**[1], [2]**
Efficiency	Robustness	**[3]**
Energy efficiency	Usability	**[4]**
Energy efficiency	Performance	**[4]**
Energy efficiency	Availability	**[4]**
Mobility	Energy Efficiency	**[5]**
Performance	Availability	**[1]**
Performance	Robustness	**[3]**
Performance	Safety	**[1], [3]**
Performance	Security	**[1]**
Mobility	Performance	**[5]**
Reliability	Efficiency	**[3]**
Reliability	Performance	**[1], [3]**
Safety	Usability	**[1], [2], [3]**
Safety	Efficiency	**[3]**
Context-awareness	Performance	**[2]**
Privacy	Usability	**[6]**
Security	Availability	**[1]**
Privacy	Availability	**[1]**
Invisibility	Usability	**[2]**
Data Input/ Accuracy	Performance	**Derived**
Information Display	Privacy	**Derived**
Security	Real time data analysis	**Derived**
Communication latency	Real time data analysis	**Derived**
Calmness	Usability	**[2]**