Context and Rationale: Achieving success at Mars requires identification of surface sites that fulfill the specified mission and science goals (e.g., depositional environments suitable for an exobiology-focused mission), while being subject to strict landing engineering constraints. As noted from past and current site selection processes, various, often independent, types of data processing, data analyses and scientific interpretations are used on a rather limited number of Mars locations (called thereafter the bottom-up approach). This potentially makes difficult some useful comparisons between the relevant findings, while necessary coordination of the various efforts deployed requires the setting up of an iterative framework of time-consuming discussion forums. In order to enhance landing site selection, it would therefore be beneficial to make available to the Mars community not only a consolidated set of data and high-level products such as landing risk maps or mission targeting maps, but also a clear process describing how to best reach the stated goals of site selection. This includes the definition and classification of requirements dealing with mission goals, science criteria, and engineering constraints.

Benifiting from a wealth of remote sensing and in-situ data of the Mars atmosphere, surface and subsurface, accumulated over the recent past, and with the perspective of several upcoming landed missions that will prepare for an eventual Mars sample return mission, there is now sufficient and timely information to build a Mars landing requirements database. We consider such database as an important pre-requisite for the selection of future landing sites in the context of the robotic Mars exploration programme, as it would constitute the main link between engineering constraints and science objectives within this programme, and could become an essential part of a broader roadmap for Mars exploration.

Database Buildup: To be used as an optimisation tool in the identification, analysis and characterisation of the most suited sites on Mars, this database shall be built over time according to a top-down, scenario-based process. Figure 1 below describes the complete database buildup, which includes the following steps.

Mission scenarios. A number of mission scenarios are designed, for each of which are established specific mission goals, science criteria and engineering constraints. A non-exhaustive list of typical mission scenarios includes EDL demonstrator mission, static lander mission, geophysical network mission, rover mission, and sample return mission. Then from mission goals can be derived mission requirements. From science interest criteria can be derived science requirements. And safety/engineering constraints are pooled together into an engineering parameters database, from which can be derived engineering requirements.

The above information is then consolidated into a Mars landing requirements database tool combining/classifying science interest with mission constraints for each mission scenario.

Scientific inputs. Science goals and criteria are collected for each mission scenario. Access to recent literature findings covering a number of locations on Mars, including potential landing site candidates, also helps putting together a database of Mars locations with scientific interests in line with missions such as ExoMars. In parallel with science criteria collection, we synthesise the highest resolution data of Mars from global to regional/local scales. This data comes from a number of readily available public sources: (i) Topographic and/or geomorphologic data (e.g., HRSC/MEX, MOLA/MGS, MOC/MGS, HiRise/MRO) are compiled to identify for example depositional environments which could serve as paleobiological repositories. (ii) Hyperspectral and/or compositional data (e.g., OMEGA/MEX, CRISM/MRO, Themis/MarsOdyssey) are utilised to identify for example areas of mineral assemblages with the highest potential for life preservation. (iii) Atmospheric data from Mars Express and the European Mars Climate Database Circulation model can be combined with data on surface conditions to identify low-risk areas to mission operations.

All available layers of information can be consolidated into high-resolution mapping products within a Geographic Information System (GIS). Coupled with the above-mentioned part of the Mars landing requirements database, the resulting information potentially leads to preliminary implications for landing suitability in terms of scientific interest.

Mission targeting. Based on a risk evaluation procedure (see study in [1], with initial results in [2]), with the aim of finding locations on Mars where both landing engineering feasibility and high science interest are in agreement, risk maps can be established and combined with the required science return from the Mars landing requirement database so as to generate mission targeting maps. A prioritised list of candidate sites can then be assembled, with relevant information fed back into the database, allowing for further in-depth anal-
yses, as required, at regional or local scales.

Figure 1: Top-down, scenario-based approach to Mars landing site selection. Inputs to the database are mission-related and science requirements for each mission scenario. These requirements are used in combination with consolidated mapping products to generate risk and mission targeting maps at various spatial resolutions. From those findings can be identified and characterised suitable sites for mission-specific purposes, allowing for subsequent, better constrained ranking of the solutions.

Feedback into Landing Site Selection Process:
The Mars landing requirements database can be used as a standalone tool in order to constrain a number of landing scenarios, or in contribution to a landing site selection process for a specific mission. In contrast to the more classic bottom-up approach, the idea is here to use such top-down, scenario-based process to get a complete, preliminary view and identification of suitable sites at global then regional or local scale, using all possible information fed into a database, and taking risk to a mission and its scientific and engineering operations into account.

The results of such process can be merged with those of any bottom-up approach used for specific missions, with the end goal of narrowing down and optimising the search for viable landing ellipses and their ranking, which is of interest to the joint ESA/NASA Mars Robotic Exploration Programme.

Conclusion: Usage of the Mars landing requirements database will first be made to support the ExoMars landing site selection in a number of ways: collect, classify and merge science and engineering requirements, derive the associated landing risk and mission targeting maps, amongst other high-level data products of interest, and provide the ExoMars community with a ranked list of most viable and scientifically suitable locations on Mars that satisfy the mission goals.