On 10 September 2017, solar energetic particles originating from the active region 12673 produced a ground level enhancement at Earth. The ground level enhancement on the surface of Mars, 160 longitudinally east of Earth, observed by the Radiation Assessment Detector (RAD) was the largest since the landing of the Curiosity rover in August 2012. Based on multipoint coronagraph images and the Graduated Cylindrical Shell model, we identify the initial 3-D kinematics of an extremely fast coronal mass ejection (CME) and its shock front, as well as another two CMEs launched hours earlier with moderate speeds. The three CMEs interacted as they propagated outward into the heliosphere and merged into a complex interplanetary CME (ICME). The arrival of the shock and ICME at Mars caused a very significant Forbush decrease seen by RAD only a few hours later than that at Earth, which was about 0.5 AU closer to the Sun. We investigate the propagation of the three CMEs and the merged ICME together with the shock, using the drag-based model and the WSA-ENLIL plus cone model constrained by the in situ observations. The synergistic study of the ICME and solar energetic particle arrivals at Earth and Mars suggests that to better predict potentially hazardous space weather impacts at Earth and other heliospheric locations for human exploration missions, it is essential to analyze (1) the eruption of the flare and CME at the Sun, (2) the CME kinematics, especially during their interactions, and (3) the spatially and temporally varying heliospheric conditions, such as the evolution and propagation of the stream interaction regions.