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Population Evacuation in Motion: Harnessing Disaster Evolution for Effective Dynamic Emergency Response

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***Abstract*—This study introduces a robust Dynamic Population Evacuation (DPE) framework in response to the escalating challenges in wildfire-urban interface regions. The DPE model elevates emergency response strategies by seamlessly integrating traffic simulation, real-time mobility tracking, optimization systems leveraging advanced algorithms, and cloud-based communication. The offline component of the framework focuses on pre-disaster preparation by optimizing the allocation of evacuation shelters and generating initial route plans for impacted populations, incorporating changing on-the-ground hazard conditions and geography. The online phase dynamically reallocates shelters and provides real-time guidance for vehicle navigation. This approach significantly improves the efficiency and safety of evacuation processes by utilizing advanced algorithms and cloud infrastructure. Key innovations include an offline planning phase, optimizing shelter allocation and route plans with a keen eye**

wildfire threats to more communities [3]. With unexpected factors such as winds or fire fuels in the region, wildfire would expand to the city level, as in the 2017 Tubbs Fire, the 2018 Paradise Fire, and the 2019 Kincade Fire. With this in mind, one could not neglect that when evacuating residents towards the urban region is one of the viable planning measures, regular urban traffic would bear large pressure [4]. Prior research has examined evacuation simulations utilizing various methodological configurations. One approach involves simulating traffic dynamics through multi-agent systems, as demonstrated by [5]–[7]. Additionally, studies have explored phased evacuation systems in conjunction with fire modeling [8]. Recent advancements have focused on integrating traffic simulation into evacuation procedures, exemplified by the