# Towards Latency Mitigation on Emergency Scenarios

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**Abstract.** Currently, over half of the world's population lives in urban environments [1], where people rely on automated services for their everyday lives. Thus, the research and industry fields are working towards providing adequate services that reach user's demands. This is the case of the SusCity project that aims at designing, developing and deploying a set of services that enable the citizens in the transition to sustainable urban systems in the transition towards a smart city. Communications in this environment can take advantages from the fog computing paradigm, like edge location, location awareness, and low latency [2]. The fog thus becomes part of the scenario as the gateway between the Internet of Things (IoT) environment (enabling the smart city development), and the rest of the Internet, where most of the data processing and storage is being conducted.

In the urban environment, one of the most important scenarios is the traffic emergency. Traffic accidents are one of the main external death causes in Portugal [3], hence, becoming a critical concern for urban environments, where special services could for instance alert a driver to take anticipated actions and thus preventing accidents. By automatizing some tasks, we could help users (drivers and pedestrians) to prevent accidents and traffic jams, and the emergency and control teams (firefighters, paramedics, police officers) to expedite their rescue missions; and in a more general way, could also help to save fuel, reduce commute times, and even help reduce pollution.

For this kind of services, one of the main constraints is the latency, since a delayed response might even cost a life. The fog scenario introduces some advantages but further improvement can be achieved. We analyzed some works on emergency scenarios as well as on latency reduction, and with this information we were able to identify some research opportunities in the field. Out of these options, we believe that a smart service placement strategy might be a promising solution for the proposed scenario, since it could raise major benefits without incurring in the downfalls of other possible approaches. Before developing such a solution, it is necessary to define a well-structured network architecture that supports an approach to reduce latency using a smart service placement strategy in a fog computing scenario. Our main goal for this work is to introduce a network architecture that enables the developing of algorithms for service placement and migration.

We took a look on emerging technologies that are being developed in order to help reduce the response time of the applications, in order to incorporate them into our architecture. One important technology is known as Content Delivery Networks (CDN). A CDN is a group of servers, with replicas of the content and the services from original servers, that allows to offload the work from those original servers [4]. Once a request is placed, the CDN locates a server closer to the user (geographically, topologically, or by any set parameter). Furthermore, SDN is a paradigm designed to standardize Application Programming Interfaces (APIs) that allows programmers the definition and reconfiguration of the mechanisms used to handle data and resources in a network [5]. SDN is based on the division of the network tasks in two planes: 1) the control plane, localized commonly in a single centralized controller in charge of making the forwarding and routing decisions, and 2) a data plane, only in charge of the forwarding functions. The decoupling of these two planes gives the network architecture more freedom to adapt to changing conditions. Finally, the ALTO protocol grants applications the possibility to make *better-than-random* decisions by allowing them to obtain information of the underlying network [6]. The protocol collects information from several sources (e.g. routing protocols, network devices, network management systems), and then creates a network map with related costs that applications can in turn use to make smart choices. This way it is feasible to increase the application performance by reducing the response times, and also decrease the amount of traffic and thus the congestion of the network.

The described technologies can help in the design of a powerful service placement strategy by combining them in an innovative network architecture, where the ALTO protocol can collect information about the delay of the network and the popularity of the services, among other metrics. The ALTO server can in turn provide this information to the CDN controller, which can use it to make an smart choice about the best place (server) to host the service, creating a dynamic environment where an SDN controller can update in real time the paths to the appropriated location, all of these while bringing the service closer to the user towards the IoT ground, by taking advantage of the fog paradigm in the smart city scenario. Such an architecture, combined with an adequate service placement strategy, can highly benefit the performance of the services in emergency scenarios by reducing the response time of the applications. The combination of these technologies has already been proven as a novel and useful approach [7], however, we are proposing to enhance it by bringing it to the fog and extending it effects and benefits to the IoT environment.

In the full paper we plan to include the graphical view of our proposed architecture as well as a detailed description of its components. This architecture will enable the design and development of innovating service placement and migration algorithms tailored to the smart city environment, with the main goal of reducing the latency of applications and services in emergency scenarios. The validation of our proposed algorithms will be done in the scope of the SusCity project.

**Keywords:** latency; fog; IoT; service placement; network architecture; SusCity

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