NosyNeighbor: Augmenting post-disaster cellular service with local cellular networks

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ABSTRACT

Cellular communications are both critical and, unfortunately, brittle during and after disasters. To address this problem, we introduce *NosyNeighbor*, an independent cellular base station that augments commercial cellular service in emergencies. By observing broadcasts from nearby commercial cellular base stations, NosyNeighbor can detect when cellular networks are unavailable or overloaded. NosyNeighbor base stations use unbiased observations to automatically reconfigure themselves, improving the availability and quality of cellular service to nearby disaster victims and first responders.

1. INTRODUCTION

To proactively address problems with wireless network coverage during disasters, we propose *NosyNeighbor*, a system designed to maximize the availability of cellular services in emergencies. NosyNeighbor features two key components: a real-time *cellular network analyser* and a *local cellular network* [1]. NosyNeighbor augments cellular network capacity in periods of high load, and provides an alternate means of cellular connectivity when commercial networks are not fully operational.

By observing control channels of cellular base stations, NosyNeighbor can assess the availability and quality of service offered by commercial cellular networks. NosyNeighbor can learn fine-grained information, such as whether or not a particular commercial base station can communicate with 911 call centers. Each NosyNeighbor base station independently reconfigures itself based on the conditions it observes, providing reliable cellular service when nearby commercial cellular infrastructure is failing to do so.

2. SYSTEM DESIGN

NosyNeighbor performs three key functions: (i) discovery of operating wireless carriers, (ii) cell characterization and (iii) augmentation of cellular services. NosyNeighbor discovers operating wireless base stations by collecting raw spectrum measurements of commercial cellular bands and analyzing these traces to determine the frequencies and technologies used by nearby wireless carriers. Once nearby cells have been identified, NosyNeighbor *characterizes the performance* of each cell by observing and analyzing the unencrypted broadcast messages of each nearby base station. Software defined radios may be used to observe several base stations simultaneously, or Android phones can be configured to log all messages they receive. NosyNeighbor is non-intrusive; all observed messages are broadcast by the carrier in plain text, and intended to be received by all phones connected to a given base station.

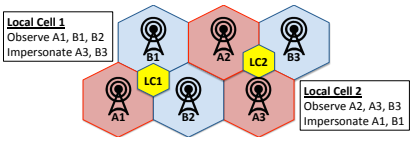

Figure 1: NosyNeighbor observing and impersonating commercial cellular base stations.

NosyNeighbor analyzes these messages to determine if networks are providing adequate service. In particular, NosyNeighbor can determine if cells are providing 911 service, are suffering from backhaul failures, are blocking a portion of users from connecting to the cell, or are unable to assign dedicated channels for voice calls.

Lastly, NosyNeighbor controls and reconfigures a local cellular base station to *augment cellular network services*, increasing the availability of cellular service in areas impacted by disasters. If a commercial base station is inoperable, NosyNeighbor attempts to attract users from that failed cell by impersonating one of the cell's neighbors. Because commercial SIM cards are programmed to preferentially connect to the issuing carrier's networks, this impersonation is required to attract users of failing commercial cells to the local cell.

3. REFERENCES

[1] M. Zheleva, A. Paul, D. L. Johnson, and E. Belding, "Kwiizya: Local cellular network services in remote areas," MobiSys '13, (Taipei, Taiwan), 2013.