FLEET TRACKING: A PROOF OF CONCEPT FOR IOT RELIABILITY SOLUTIONS

IMPROVING BROADBAND ACCESS IN RURAL VIRGINIA

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SOCIOTECHNICAL SYNTHESIS

The digital divide, a disparity in broadband Internet access between urban and rural populations, causes economic disadvantages for those who lack broadband. The technical and STS research present technical and sociotechnical solutions to this digital divide. The technical solution introduces two technologies that can improve the reliability of Internet of Things applications, one supporting information transfer when broadband is unavailable. Using Virginia as a case study, the STS research explores the reasons why past efforts have failed to bring broadband to rural regions, and it suggests improvements to future initiatives. This STS research motivates and strengthens the technical solution, answering why new technologies are necessary and how they can be more universally available than broadband Internet.

The immediate goal of the technical research is to improve the reliability of applications in the Internet of Things, the network of wirelessly connected devices. Such applications frequently rely on non-rechargeable primary cell batteries and pre-existing communications infrastructures, such as the Internet and cellular networks. In rural environments, this dependence renders applications impractical. The technical solution introduces solar energy harvesting and LoRa, a frequency modulation technique, as alternatives to such conventional methods. As a proof-of-concept, the project also presents a prototype for a GPS-based vehicle tracking system, the Fleet Tracker, that uses both techniques. More broadly, the research demonstrates that LoRa modulation can enable information transfer in the absence of broadband Internet availability.

The result of the technical research is a physical prototype of the Fleet Tracker. Three printed circuit boards house the hardware foundation for the system, including the solar energy harvesting and LoRa communications subsystems. A firmware library controls basic operations, manages device energy consumption, and ensures data fidelity during information transfer.

Testing demonstrated that the harvesting subsystem sustains the system's functionality even when harvesting minimal energy. Additionally, LoRa modulation supports data transfer independently of pre-existing infrastructures. These results indicate that using solar energy harvesting and LoRa modulation can improve reliability for Internet of Things applications.

The STS research answers why past rural broadband initiatives have failed, and how future efforts can be more successful. Focusing on Virginia, the research draws from the Actor-Network Theory framework to define a global and local network in the rural broadband problem. It determines the key actors in each network by analyzing journal articles on universal broadband access. The research then demonstrates that the success of broadband initiatives is contingent on the correctness of interactions between the networks. Employing case studies that consider other problems with a two-network structure, the STS research defines what makes interactions correct and applies this model to past initiatives. With these methods, the STS research exposes the flaws in past efforts for universal broadband access and the potential for future successes.

The STS research first develops a model for optimal interactions between the global and local networks. This model calls for mediators that moderate such interactions, and it defines three pre-requisites for a mediator to do so successfully. Applying the model to past mediators reveals that none have fulfilled all three requirements. The model also guides two suggestions for future rural broadband initiatives. Mediators should seek alternatives to subsidies to support universal broadband access, and a state-level agency in Virginia should act as the mediator between the global network and the Virginia local network.

The technical and STS research present two solutions that together help to narrow the digital divide. The technical research introduces LoRa modulation as an alternative to broadband

Internet. From a sociotechnical perspective, the STS research suggests avoiding subsidies and using state-level agencies as mediators to help bring broadband to rural communities.

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