

# Distributed Server Architecture for the Over-lay Network Delivery of Immersive VoIP

Ying Peng Que, Farzad Safaei, Paul Boustead,  
Smart Internet CRC,  
Telecommunications and Information Technology Research Institute,  
University of Wollongong, Australia  
Email {ying, farzad, paul}@[titr.uow.edu.au](mailto:titr.uow.edu.au)

## *Abstract*

*Voice-Over-IP (VoIP) technology could enhance the interactive user experience of Distributed Virtual Environment (DVE) applications in comparison to the simple text-chat service. One typical example of such VoIP services is the success of Xbox LIVE and PlayStation LIVE in the realm of multi-player online games. However, the current generation of VoIP services deliver mono voice streams independent of the context of the virtual environment, which do not contribute to the user's sense of immersion in the virtual world. We believe a future development of VoIP service for DVE is the Immersive VoIP which delivers to each user a real-time mix (Auditory Scene) of the voices of surrounding users in the virtual world, all rendered with the distance and directional cues corresponding to their respective virtual world positions as shown on the local visual display.*

*Two of the key scalability challenges in the network delivery of Immersive VoIP are access bandwidth costs and voice transmission delays. In this work, we propose to use a client-server architecture with the Latency Driven Distribution of multiple servers to perform Auditory Scene Creations (ASC) for users. We have formulated two ASC Server Assignment Algorithms using Linear Programming (LP), i.e. the Bandwidth Unconstrained Algorithm and the Bandwidth Constrained Algorithm. As observed in the various scenarios simulated, the two server assignment algorithms enables the distributed server architecture to consistently offer a better balance between delay and access bandwidth cost when compared to both the Peer-to-peer (P2P) and central server architectures employed in the prior art. An important finding is that, perhaps contrary to intuition and practice, the virtual world proximities of users do not have any significant influence on the optimal ASC server assignment. In order to deploy our server assignment algorithms in real-time, we have also devised a greedy heuristic to overcome the computational inefficiency of the LP-based Bandwidth Constrained Server assignment algorithm. In most cases, the performance gap between the greedy heuristic and the optimal is between 10% and 20% in delay deviations, and between 10% and 30% in access bandwidth cost.*