

# IREEL: Remote Experimentation with Real Protocols and Applications over Emulated Network\*

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## 1. WHAT IS IREEL?

In the context of education, experimenting with networking protocols is a very important step in the learning process. These experiments are usually achieved using either simulation or real test bed. Progresses in high speed processing and networking enable the development of network emulators. These emulators use both real protocol implementations and network models that allow a controlled communication environment to be created.

IREEL stands for Internet Remote Emulation Experiment Laboratory. It provides a way to achieve experiments with real Internet applications and end-to-end protocols in the context of networking courses. This platform consists of a remote controlled network emulator system and end-stations that offers a set of pre-defined applications and protocol mechanisms for testing. Control on the emulation system and on the end-systems is given to the students in order to perform tests, measurements and observations of the protocol in specific networking conditions. In addition, a set of end-to-end mechanisms examples are provided. These mechanisms mainly focus on transport and application protocols that might be useful for networking online courses.

## 2. THE IREEL EXPERIMENT PROCESS

The students are able to conduct experiments using a large set panel of real applications (e.g., ftp, http, iperf, audio, video, etc.), protocols (tcp, udp, and other transport protocol) and network conditions adapted to various realistic situations. These various education materials are previously arranged to construct experiment scenarios proposed by the course teacher to the student. Examples of such scenario are e.g., reliability basic experiments, streaming audio analysis, evolution of HTTP protocol, or TCP over satellite study.

Remote students are able to access the IREEL platform via a simple web browser, allowing them to easily define, sched-

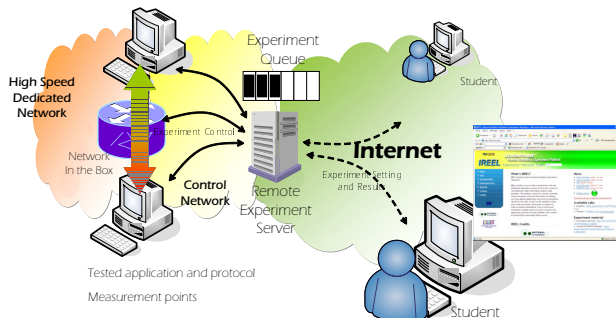


Figure 1: The IREEL platform.

ule and analyze their experiments. This consists of setting up the emulation system with proper network impairments models, associated to the required network conditions. Furthermore, the experimenter will be able to select and configure the application and/or transport protocol mechanisms over a predefined set of available parameters.

Several experiments can be scheduled. They are queued in the system and will be processed when sufficient resources are available. The experiment in progress is carried out automatically in real-time. This is done over a dedicated experiment network where QoS is impaired according to the emulation configuration. End-stations are exchanging packets using real applications and protocols, depending on the experiment setup. Once the experiment is finished, the experimenter can access to the results via the Web interface. The results are provided in various complementary forms such as packet traces (at sender and receiver side) and performance measurements graphs (e.g., throughput, loss, etc.). To highlight the advantages of using real protocols and distributed applications, it is also possible to receive a record of applicative results. For instance, in the context of multimedia, the resulting (altered) audio or video can be provided. Using these results and the lab description, the experimenter will be able to compare and understand the function and effects of various network QoS or protocol mechanisms.