Open Video Chat: Open Source Development on a Constrained Platform

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The **Open Video Chat** project, an initiative to develop a wholly Free/Open Source videoconferencing application for the "XO" series of laptops distributed by the One Laptop per Child Foundation, was started in the spring of 2010 under the auspices of the Rochester Institute of Technology's Lab for Technological Literacy. The project was originally conceived by the Institute as a cooperative educational opportunity funded by PEN-International, a multinational partnership of colleges and universities with the goal of improving post-secondary education of deaf and hard-of-hearing students worldwide. In funding the project, PEN-International hoped to bring videoconferencing capabilities to two of their affiliated primary schools in the Phillipines and Vietnam - as well as to deaf and hard-of-hearing students in developing nations everywhere, through synergy with the One Laptop per Child initiative.

As developing nations often do not have resources to provide sufficient educational resources for students, the One Laptop Per Child project was spearheaded by the United Nations to develop an affordable, robust learning tool to distribute *en masse* in needy areas. The end product was their "**XO**" series of laptop computers - an inexpensive, hardy platform based on the x86 architecture and the Fedora Linux operating system. In lieu of a standard desktop environment, the XO runs a new software environment called **Sugar**, designed with an intuitive interface that encourages constructive learning. Applications in the Sugar environment are called **Activities**; Activities can be shared between students' laptops using the XO's mesh networking capabilities, allowing students to share screens or collaborate with one another.

In spearheading a videoconferencing application for the XO platform, PEN-International hoped to leverage the ongoing deployment of these devices to the benefit of deaf and hard of hearing children in developing countries where traditional telecommunications devices for the deaf (TDDs), video communication networks, and relay services are unavailable. The XO series of laptops, with modest computing power and a built-in webcam and microphone, seemed like an amiable fit; an early videoconferencing prototype had been developed for the XOs in the past, though performance was sub-par and the prototype did not work with modern versions of the XO firmware.

To bootstrap the project, PEN-International hired three co-op students in the spring of 2010 - Justin Lewis, and us authors Fran Rogers and Taylor Rose - to begin work on Open Video Chat. Minimum goals for the spring included two-way, real-time streaming video at a rate of at least fifteen frames per second, determined to be the minimum for intelligible sign language communication; a textual chat feature for interacting with non-sign-language speakers; and an intuitive user interface suitable for children.

By the end of spring quarter, the team delivered a working prototype for the XO-1.5 devices, achieving reasonably acceptable performance. While the prototype worked, we were dissatisfied with the lack of polish and stability in this spring prototype: connections were prone to fail; proper NAT traversal was missing; codec settings were hard-coded. Many of these limitations were due to our use of a simple, *ad hoc* protocol developed on the spot; compressed video was sent via the unreliable UDP protocol, with no proper signaling or codec negotiation. We decided to apply for a grant through the Summer Undergraduate Research Fellowship program to overhaul the application and fix these limitations.

After exploring our options, we decided that our goal for the summer would be to replace the *ad hoc* protocol in our spring-quarter prototype with an existing Open Source implementation of proper videoconferencing standards. This would greatly improve the reliability of our application, allowing us to leverage existing, well-tested code, and enabling the highly desirable feature of inter-operating with existing videoconferencing networks and applications like SIP and Google Talk.

One of the existing software libraries we would be incorporating is **Telepathy**, a communication and presence framework developed by the UK-based Collabora Limited in conjunction with the freedesktop.org project and the wider Open Source community. The aim of Telepathy is to present a uniform interface to instant messaging and presence services within the desktop environment via the **D-Bus** inter-process communication standard, allowing multiple client applications to manage different conversations over the same connection. Telepathy does this by abstracting conversations, file transfers, streamed media, etc. into the concept of a “Channel”; Channels are created and managed by Telepathy, which routes them to the appropriate client.

An older version of the Telepathy framework comprises a crucial part of the Sugar environment, underpinning Sugar’s collaboration and presence services. Sugar’s Presence Service uses the Telepathy API to discover other Sugar clients via the XMPP instant messaging protocol - whether on a link-local network or a central XMPP server - and advertise running activities and services. It automatically provides connected activities with Telepathy Channels for text chat and arbitrary inter-process communication.

The principal authors of Telepathy at Collabora also authored a companion library **Farsight**, which is a framework that adds videoconferencing capabilities to Telepathy. Given the appropriate streamed-media and signaling Channels from Telepathy, Farsight will start and maintain a videoconference between two or more Telepathy users, automatically handling such details as negotiation of audio and video codecs, NAT traversal, and bit rate.

Integrating Farsight into our application seemed like it would be a straightforward proposition. As Sugar already utilizes Telepathy internally, and Sugar Activities such as our application are already provided with Telepathy Channels managed by Sugar’s Presence Service connecting to other Activity participants, we decided it should be possible for our application to request the appropriate Channels from Sugar, connect Farsight to them, and have working videoconferencing.

In mid-July, we attended a “Hackfest” meeting at One Laptop per Child headquarters in Cambridge, Massachusetts. Two software engineers from Collabora intimately familiar with the Telepathy and Farsight frameworks were on hand to advise us and lend a hand with our project. A particularly fruitful area of discussion we had was on the differences between “standard” Telepathy (as implemented on a standard Unix desktop like GNOME or KDE) and the specially tailored version of Telepathy used by the Sugar environment. They also helped us work around and apply fixes for defects in Farsight and the Telepathy backend.

Through the remainder of July, we attempted to construct a working prototype using Farsight to communicate between two XO-1.5 devices. However, we repeatedly ran into the same defects that Collabora’s engineers had fixed, despite always running the latest development versions of the XO firmware. This is where we ran into a substantial roadblock. We discovered that all versions of the XO-1.5 firmware are built using an old version of Fedora GNU/Linux distribution, Fedora 11; this version of Fedora, released in May 2009, has been considered officially end-of-life since June 2010, and updates to components like Telepathy and Farsight are no longer being incorporated. While we discussed the feasibility of replacing Fedora 11 with the newer, currently supported Fedora 13 with One Laptop per Child engineers, they indicated that they did not have any plans to port newer versions of Fedora to the XO-1.5 (or XO-1) hardware.

One additional avenue we explored was building the components we needed from source code, retrofitting them into the older operating system of the XO, and including these retrofitted libraries in our application package. This is a considerable undertaking, considering the latest versions of Telepathy and Farsight depend on newer versions of components, like GStreamer, that Sugar also depends on. However, by this time the ten-week research session was drawing to a close, and we decided it would be best to explore this at a later period.

Unfortunately, we were not able to integrate Telepathy and Farsight into our project during these ten weeks, though we do feel the goal is still achievable at a later date, particularly as development is progressing rapidly on the Sugar environment, and the One Laptop per Child operating system is still in a state of flux. Engineers with Sugar Labs are currently radically redesigning the presence and collaboration subsystems of Sugar, smoothing out the differences between Sugar's version of Telepathy and standard desktop Telepathy, and making obsolete the Sugar-specific Presence Service.

Additionally, One Laptop per Child has hinted that they are considering replacing the current Fedora/Sugar based OS wholesale with a new OS based on Google's Android platform, which does not use the Telepathy/Farsight stack, but contains its own videoconferencing capabilities which may be easier to leverage.

While we did not quite succeed in the original goals we set out to accomplish, the experience was very enlightening for us - particularly the experience of working with the wider Free/Open Source community. Help from developers of components we depended on was essential: whether on mailing lists, Internet Relay Chat, or in person at conferences. Sometimes an question will go unanswered, and it is easy for an online *faux pas* to turn into an argument if one is not careful, but we learned that with a bit of persistence and a thick skin, one can gain valuable experience from the development community.

Looking back, we can identify some aspects of our work that may have improved our chances of success. Perhaps our biggest mistake was not setting up a "bleeding edge" development and testing environment on the XO devices as a prerequisite - we would have discovered the issues inherent in the XO's aging firmware, and would have been able to tackle head-on the problem of incorporating the latest versions of components like Telepathy and Farsight and any interdependency problems this may incur.

Secondly, we feel we could have worked more intimately with the community than we did. The Free/Open Source community - made up largely of volunteers, working on their own time - is known for being sharp-tongued and impatient at times, and perhaps the cutting remarks caused us to ask less questions than we should. We did learn quite a bit about asking the right questions in the correct manner - since there are so many interlocking components involved in our work, some of which had never been fitted together in quite the same manner, we learned to pinpoint exactly which project we required assistance from, and kept many Internet Relay Chat conversations open with each component's developers on the line.

Even with the setbacks this project has seen recently, all hope is not lost. With newer software from Sugar Labs and hardware from One Laptop per Child on the horizon, our goal of open-source videoconferencing for deaf and hard-of-hearing in developing countries may be even closer than one would think. Given a little more time and development, we hope bringing these vibrant new Deaf communities together through the gift of technology will be possible in short order.