



PARMA POLYHEDRA LIBRARY INTERACTIVE WEB-BASED VISUALIZATION SYSTEM



1 INTRODUCTION

The **Parma Polyhedra Library (PPL)** is a C++ library providing numerical abstractions especially targeted at applications in the field of analysis and verification of complex systems. Polyhedra are geometric representations of linear systems of equations and inequalities and provide an aid to the understanding and implementation of computer programs. **The problem is** that polyhedra of 3 or more dimensions represented by equations and inequalities can be difficult if not impossible to visualise. **The project aim is** to provide an interactive web page which allows users to step through an analysis of their programs and view the polyhedra.

2 PROPOSED SYSTEM

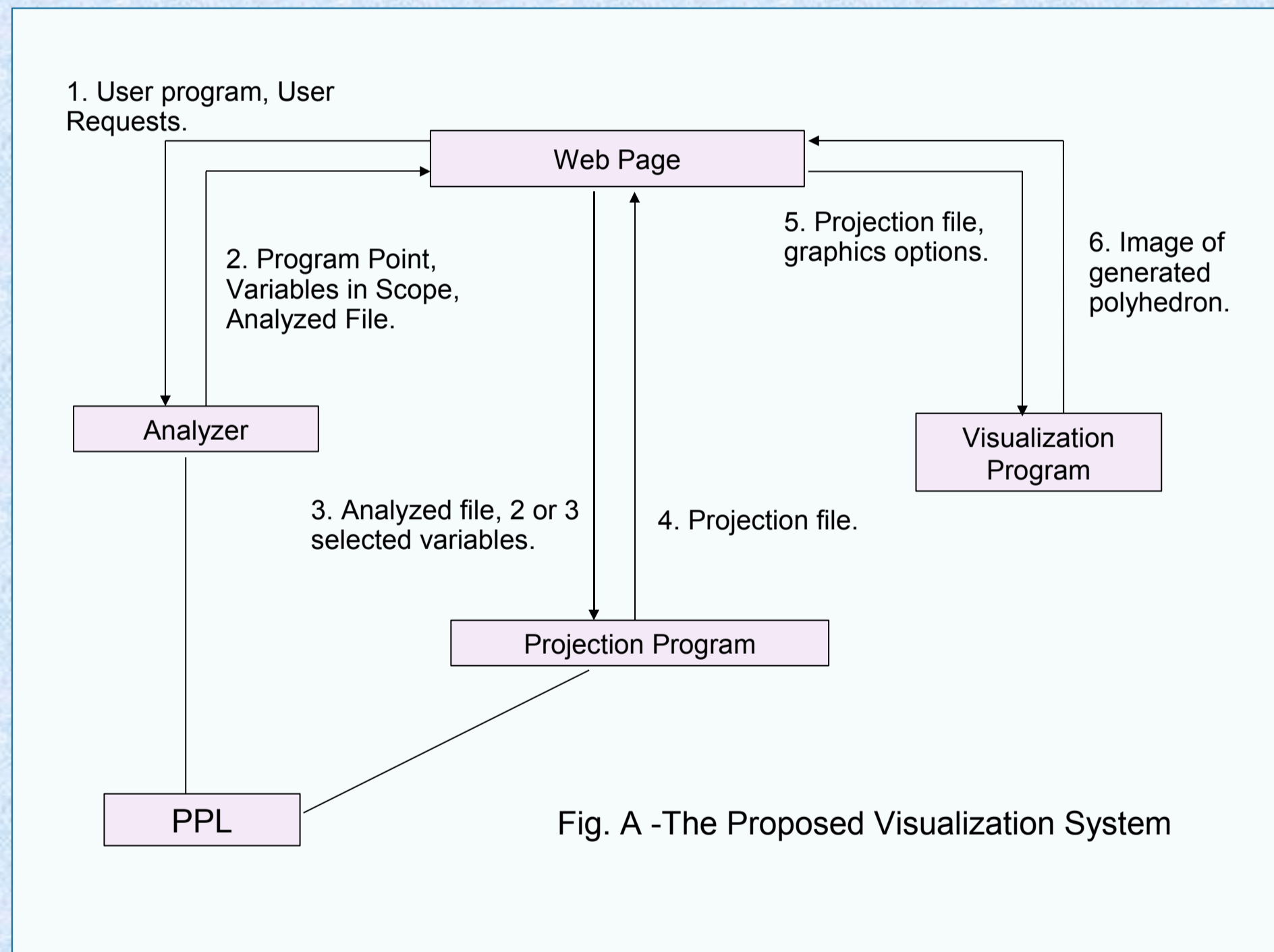
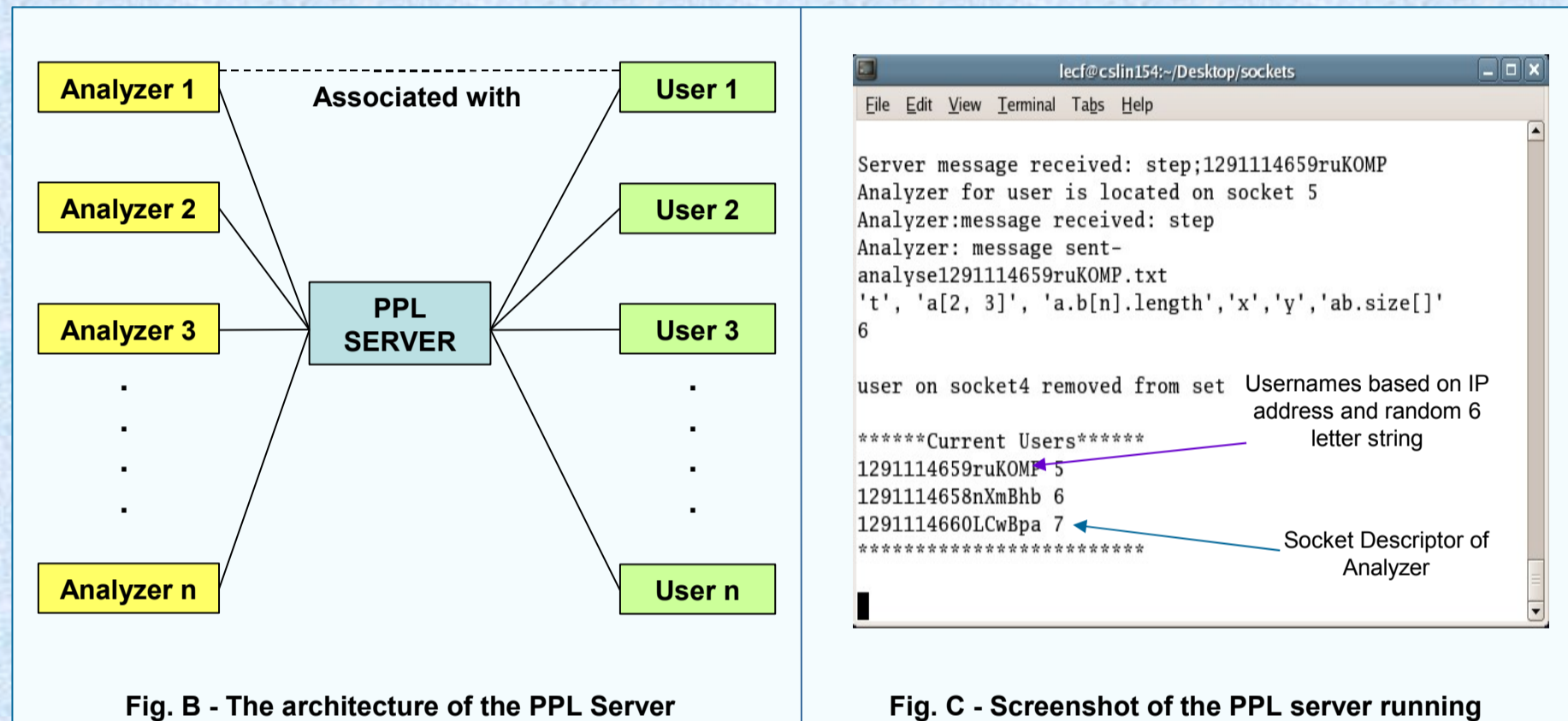


Fig. A -The Proposed Visualization System

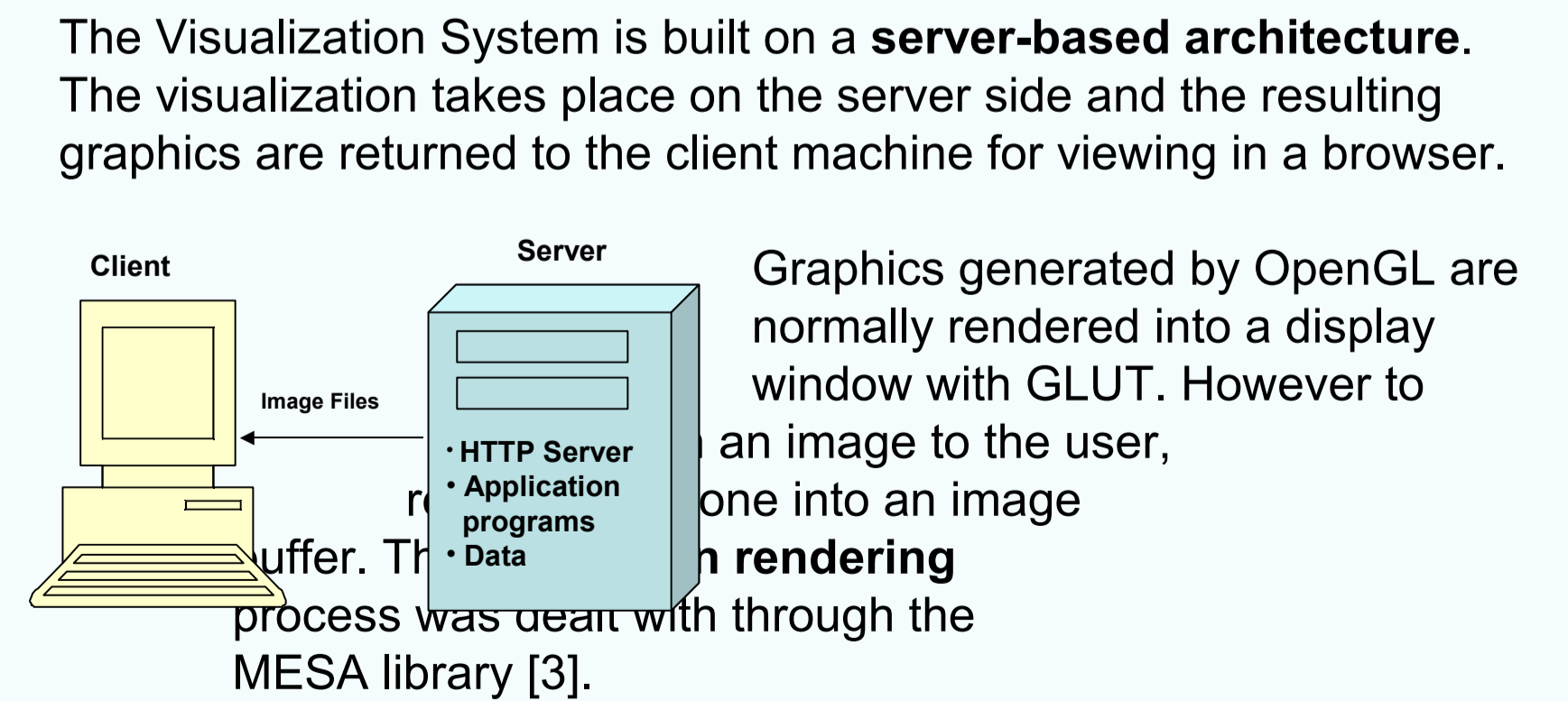
Analyzer: Takes a program (user's source code or a pre-defined example) and a step in the program and returns a description of a polyhedron; this represents an over-approximation of the possible values of numerical variables in scope at that step.
Projection Program: Takes 2 or 3 specified variables and the description of the polyhedron and returns the projection of the polyhedron onto these variables. The output is as required by the visualization program.
Visualisation Program: Takes the description of the 2 or 3 dimensional polyhedron and various graphics options and provides an image for including in the web page. This part of the system was developed in OpenGL by G.D.Howard (see [4]).

3 METHODOLOGY

The web page (See Figure A) passes information via **html forms** to the different programs. A drawback of using CGI to retrieve the form data from the browser is that a new CGI process commences with each retrieval, preventing continuous communication with a process (as necessitated by the Analyzer). For this project, sockets were used to provide **bidirectional inter-process communication** between the processes wherever they reside. The sockets are provided by an original **socket class** in C++ (following the approach in [2, 5]) to create a **PPL server program**.



The server program has a **multiplex architecture** for handling several clients in a single server process (see Figure B). When new clients (users or analyzers) connect, they are added to a **watch list** of socket descriptors. The operating system then tells the program which clients (if any) need to be serviced or if a new client has established a connection. When a start request is received a new analyzer is forked and the pairing between users and analyzers is maintained using the socket descriptors (see Figure C). After a specified period of inactivity, timeouts kill inactive processes.



4 FINAL PRODUCT

This is a screenshot of the user's web page

The user will be provided with example programs as well as being able to upload their own.

The user will have the ability to select a step, break out of a loop or a function.

When stepping through the program, the current line will be highlighted.

The user can manipulate the image through graphics options.

The user can choose which variables to project onto.

5 CONCLUSION

- The methods used in this project provides one way in which a interactive web-based visualization system is created.
- The Visualization Program should extend visualization to other domains such as "octagons", sets of polyhedra and "grids" (lattices). The Analyzer is not yet fully functional. However, the framework for connecting the programs represented in Figure A is all in place.
- Eventually the PPL will release a downloadable version of the visualization system.
- When fully functional, the system will be installed and accessible from the PPL website [1].

References

- R Bagnara, P M Hill, E Zaffarella - "The PPL Website" <http://www.cs.unipr.it/ppl>
- B Hall - "Beej's Guide to Network Programming Using Internet Sockets" - <http://beej.us/guide/bgnet> - (2005)
- B Chen, H H Chen - "Interpretive OpenGL for Computer Graphics" - <http://iel.ucdavis.edu/publication/2005/CG.pdf> - (2005)
- G.D. Howard - "MSc Project 3D Visualization" - (2006)
- Keith Haviland, Dina Gray, Ben Salama - "Unix System Programming second edition" - Addison Wesley - (1998)