

Equipment & FLOWEX Software Setups and Properties

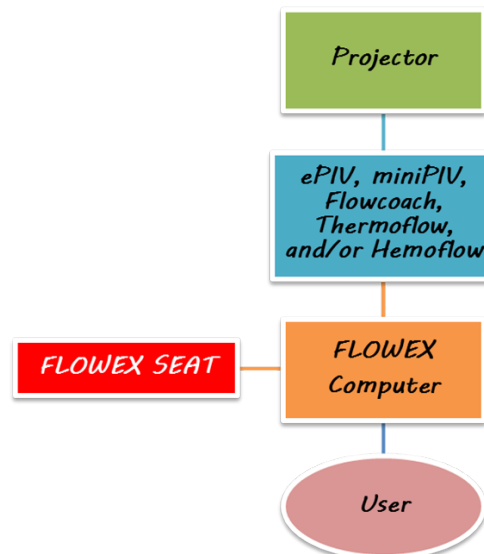
This document describes various Equipment and FLOWEX setups suitable for classrooms and labs.

A few facts:

- Each FLOWEX software instance (FLOWEX computer booted via the FLOWEX software) can support groups of 2-4 students.
- Software can be shared by multiple students either using the same computer, or additional computers (e.g. student notebooks) via connecting to the FLOWEX server.
- All students can share the same software in "read only" mode, however, only one student can interact with the software at a time. This fact is crucial in understanding why we may want multiple Equipment and multiple FLOWEX software. If one student issues a command, the system is locked during that command, no one else can send another command to the server. Once the command finishes, everyone see the results. The software's state is updated for everyone. There is only one FLOWEX instance running on the same machine. You cannot run, for example, two PIV analyses simultaneously by two students. The most recent one will overwrite the old one. There are various reasons for that; for one, PIV and CFD computations are very expensive. We cannot run multiples of them at the same time. Also, camera hardware can only be used by one program at a time.

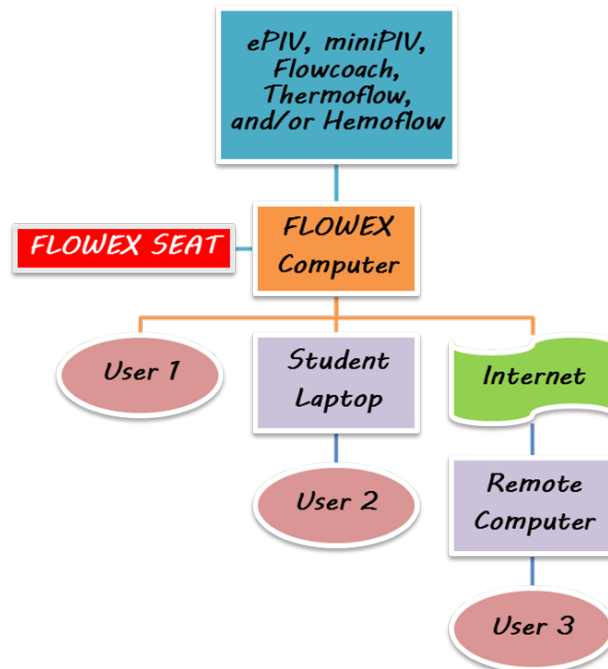
1. Single Equipment + one FLOWEX server

This setup is best for demonstrations and lectures in classroom where the instructor or the TA uses the device to demonstrate various flow phenomena and perform experiments. Students don't get a hands on experience.



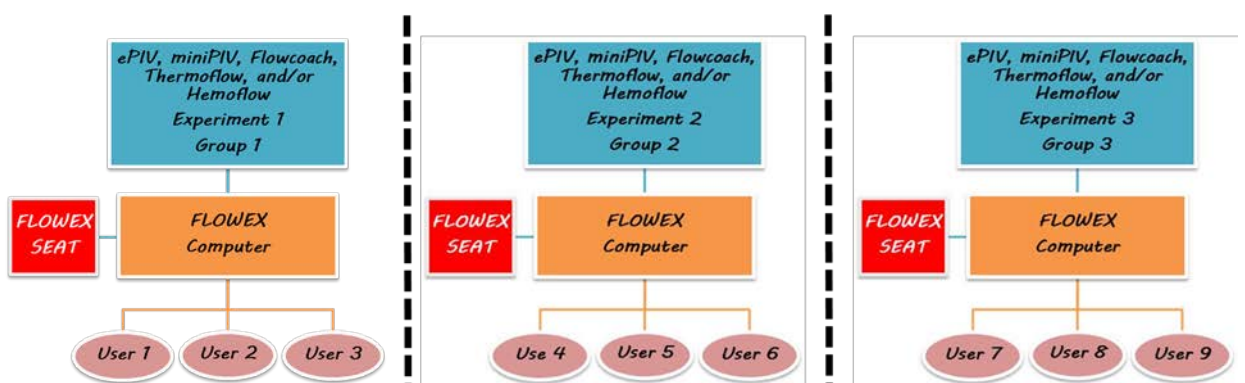
- Only one user (e.g. instructor) or a group of students sharing the same computer.
- No hands-on experience.
- Only one experiment at a time.
- Cheapest setup.

2. Single Equipment + one FLOWEX server, multiple computers and users



- Same as above, but multiple students may connect to the same FLOWEX server
- In the above example, one student connects to FLOWEX server directly, one uses his/her laptop, and connects remotely over the internet.
- For remote access, firewall and routers may need to be configured to allow access to FLOWEX computer.
- Only one experiment at a time.
- Group of 2-4 students may share the same experiment and see the results simultaneously.

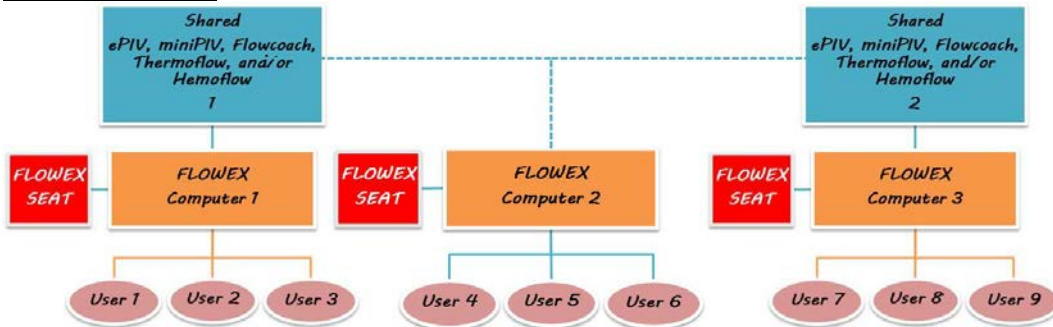
3. Multiple Equipment+ multiple computers with FLOWEX



- In the above example, we have a lab capacity of 9 students.
- 3 groups of 3 students per group, working independently on 3 independent experiments.
- Each group may experiment with a different setup / obstacle / geometry (or the same geometry if desired).
- Each group is independent, they don't need to take turns, they go at their own pace.

- They can restart the experiment and can recapture new set of images to process at any time.
- Hands on experience for students.
- Recommended 1 Equipment (and one FLOWEX computer) per group.

4. **Multiple Equipment + multiple computers with FLOWEX (# FLOWEX Computers > # Equipment)**



- Similar to above, but, we have 3 FLOWEX computers but only 2 Equipment.
- 3 groups of 3 students per group, working semi-independently.
- Groups need to share the Equipment.
- Only one group can use the same Equipment at a time.
- Once images are captured, Equipment can be disconnected and can be used by another group. Rest of the experiment (PIV, CFD etc.) can be done independently. This group no longer need to wait for anyone else and may proceed at its own speed, as long as they do not need to restart (capture another set of images).

Example

We start with FLOWEX Computer 1 connected to Shared Equipment 1 and FLOWEX Computer 3 connected to Shared Equipment 3. FLOWEX Computer 2 is not connected to any Equipment. Group 1 sets up experiment 1, captures images. At the same time, group 3 sets up experiment 3 and is working on capturing images. Group 2 has to wait, since there is no available Equipment that are free. Let's say group 1 is faster than group 3 and is finished with capturing images. FLOWEX Computer 1 is disconnected from Shared Equipment 1. Group 1 can no longer capture images, but may continue to run PIV or CFD. FLOWEX Computer 2 is now connected to Shared Equipment 2. Group 2 can now capture images and may proceed. If group 1 needs to recapture images, it has to wait for an available Equipment.

Recommendations

- For best lab experience: Highest hands on experience. Number of Equipment and computers is equal to 1/2 to 1/4 of total number of students in lab session (depends on desired number of students per group).
- For decent lab experience: with tighter budget. Decent hands on experience. Number of total FLOWEX computers/software licences is 1/2 to 1/4 of number of students in lab session. Number of Equipment is slightly lower, some groups sharing Equipment.
- For bare minimum for classroom use: No hands on experience. Very tight budget: One Equipment + one computer connected to a projector.