"Issues Associated With Remote Experimental Participation"

White Paper for FESAC International Collaborations Panel

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Overview:

Scientific collaboration, both international and domestic, is already enhanced via technologies that allow remote participation in experiments and scientific discussions. This mode of collaboration, while not ideal in all ways, offers several distinct advantages:

1. It lowers the travel and relocation burden on collaborators. Moreover, in addition to team members who may be on-site temporarily or permanently, others may participate remotely thus engaging a larger group with a broader range of expertise and increasing the effectiveness of the collaboration. Not everyone of interest to the program can or will travel/relocate.
2. It allows for more flexible scheduling at the experimental facilities. In the case (not rare) where an important diagnostic or auxiliary system is not functioning as needed, it is common practice to defer the experiment until the situation is rectified. When collaborators travel long distances, for short visits particularly, it is not practical and as a result, experiments are either cancelled or run in a sub-optimal way.
3. Travel costs can be lower. Usually the most effective collaborations include both on and off-site components, where relationships and procedures are first established with on-site visits. Thus travel expenses can be reduced but not eliminated.

Situation analysis:

The U.S. fusion program was a pioneer in carrying out science in this manner – going back almost twenty years [1-3]. Remote participation is now a regular part of facility operations. U.S. fusion experimental groups have participated and led experiments on international facilities and at the same time, regularly host remotely, international partners on our own facilities. Recent examples include H-mode pedestal, PWI and scenario experiments on C-Mod led by remote session leaders from the ITPA or ITER teams [4,5]; remote operation of the EAST and KSTAR experiments by DIII-D and PPPL staff [6,7]. At the same time this work prepares the ground for research on ITER, where the team will be distributed around the globe. (In fact this is literally built in - the office facility being constructed is far too small to house the entire physics research team that will be required.)

Issues and needs:

While effective enough to attract usage, the tools for remote participation could use substantial improvement. These include:

1. Improvements in the underlying network. Throughput and bandwidth are not always sufficient for the volume of data required. Some of this is due to inherent latency in transcontinental connections and under-provisioned networks, while other problems arise from national network configuration and policies. That is, some problems are technical and may be fixable with technology alone, others aren't. National infrastructure and the ability of the scientific communities to influence that infrastructure to optimize their work varies greatly from region to region. Since traffic often crosses multiple administrative domains, optimizing performance for our applications is not always straightforward –

changes in technical configuration and policy need to be negotiated case by case. The best time to do this may be before collaboration agreements are "signed", rather than afterwards. It also should be recognized that in some cases (e.g. the Chinese national firewall), our ability to effect change is probably nil.

2. Better and more widely deployed monitoring portals and tools. End users often do not always have access to tools that allow them to readily assess the state of the network and thus the expected performance of remote participation tools. This can lead to unrealistic expectations and frustration or conversely to unnecessary passivity in the face of fixable problems.
3. Tools for telepresence. While these are steadily improving, they do not yet come close to supporting the level of *ad hoc* interpersonal communications that characterize fusion control room operations.
4. Documentation. The quality of documentation and information sharing about experimental operations, data management systems, analysis and visualization tools, remote participation tools, etc. is not what it needs to be. A significant and ongoing investment will be required to make the most of capabilities that are provided.

Overall, remote participation can be an effective multiplier on investments made in international collaboration - however, not without some substantial investment in hardware, software, research, development and ongoing support.

References

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