Towards consumer-oriented photonic Grids

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1. Introduction : future Grid requirements

Grid technology is currently reaching a level of maturity allowing deployment of large test infrastructures world wide, leveraging huge computing facilities to the academic and scientific community (important examples of such infrastructures include the EGEE [1] and TeraGrid [2] deployments in Europe and the US, respectively). Two important trends can however be discerned in current grid developments: the tendency to deploy dedicated optical network facilities [3] (instead of sharing network connectivity with other applications) and the adoption of grid technology beyond the e-science community.
Especially the envisaged usage of grid-aware applications by home-users entails developments towards more scalable and hence distributed resource management schemes. Current grid systems are indeed specialized in handling (extremely) large jobs submitted by a relative small number of users. Future applications including multimedia editing [4], online gaming and virtual reality immersion [5] have the potential for an enormous user base. The number of jobs launched will not only increase because of the increase of users but also due to higher degrees of parallelism (resulting in a larger number of smaller jobs) typically encountered in multimedia applications. These new application areas for grids result in novel requirements: scalable job management (centralized and hierarchical approaches currently adopted do scale to the envisaged number of service requests), high connectivity for end users, provisioning of computing facilities for residential users, offering guarantees on service levels (service availability and guarantees on job completion time) and flexible resource management (limited or ideally no resource configuration to limit the overhead relative to the job execution time).

2. Optical Burst Switched Grids

The need for distributed and flexible (computational, storage and connectivity) resource management together with the trend towards deploying dedicated optical infrastructures to match the aggregated bandwidth requirements of a large audience makes the Optical Burst Switching technology of particular interest. Realizing a straightforward relation between the grid layer and the network infrastructure by mapping a single atomic job to a single optical burst offers interesting benefits in terms of system elegance and associated performance gains and robustness.
The resulting architecture is shown in figure 1. A grid edge device aggregates the service requests and transforms each job to its optical burst equivalent. The job is subsequently routed through the optical network, based on its job requirements. To this end, each network node holds a view on the available resources. The granularity of this view is coarser with increasing distance to the resources. Routing a job towards a suitable computing system is done through the anycast principle: any resource able to satisfy the requirements encapsulated in the burst (in terms of required number of computing power, and job completion time) is allowed to handle the job. Transmitting job results back to the job requestor is obviously done through conventional unicast.

Advantages offered by this architecture can be summarized as follows:

- Sharing of the same optical infrastructure amongst many applications
- Scalability is achieved through highly decentralized resource and job management.
- Avoiding to set up (long lived) optical circuits allows to flexibly use the network infrastructure (allowing traffic bursts from one user/application to temporarily use more bandwidth)
- OBS QoS-features (by adjusting header – payload timing) can be used to distinguish between different application scenarios (streaming applications, interactive applications, background low priority computing applications, …).
- Low overheads due to avoiding circuit set-up and due to purely optical forwarding.

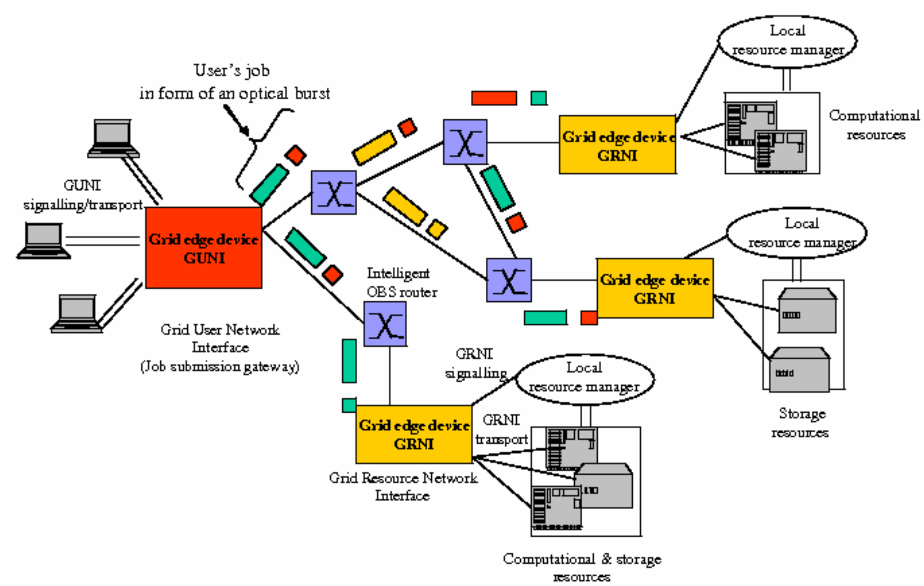

Fig. 1. Overview of the proposed OBS grid architecture.

3. Conclusion

A novel OBS-based photonic grid architecture has been proposed, offering considerable advantages in terms of scalability and flexibility to efficiently provide computing, storage and network resources to novel applications. More details on protocols and performance (more in particular in comparison with circuit switched grid infrastructures) will be presented at the conference.

References

[1] Enabling Grids for E-Science in Europe project, website, http://public.eu-egee.org/

[2] The TeraGrid project, website, http://www.teragrid.org/

[3] L. L. Smarr, A. A. Chien, T. DeFanti, J. Leigh, P. M. Papadopoulos, "The OptIPuter," Communications of the ACM, 46(11):58--67, Nov 2003

[4] Li Zong and Nikolaos G. Bourbakis, "Digital Video and Digital TV: A Comparison and the Future Directions", Proc. of the International Conference on Information Intelligence and Systems, Mar 1999.

[5] Tsuneo Ikedo, "Creating Realistic Scenes in Future Multimedia Systems", IEEE MultiMedia, 9(4):56--72, Oct 2002.