Posed Questions:

- What does the component you represent expect from GGOS?
- What will the component you represent contribute to GGOS in terms of products and other contributions?
- What are the critical points you see concerning GGOS implementation and goals?
- What is the GGOS contribution to GEOSS (and also other organizations such as IGOS-P)?
- The representatives of the services should also comment on how they consider to contribute through GGOS to GEOSS.

The Role of GGOS

The GGOS project was established in early 2004, under the International Association of Geodesy (IAG) new organization, to coordinate geodetic research in support of scientific applications and disciplines. GGOS is intended to integrate different geodetic techniques, models and approaches to provide better consistency, long-term reliability, and understanding of geodetic, geodynamic, and global change processes. Through the IAG’s measurement services (IGS, ILRS, IVS, IDS, and IGFS), GGOS will ensure the robustness of the three aspects of geodesy: geometry and kinematics, Earth orientation, and static and time-varying gravity field. It will identify geodetic products and establish requirements on accuracy, time resolution, and consistency. GGOS will work to coordinate an integrated global geodetic network and implement compatible standards, models, and parameters.

We expect that one of the fundamental goals of GGOS is the establishment of a global network of stations with co-located techniques, to provide the strongest reference frames. GGOS will provide the scientific and infrastructural basis for all global change research and provide an interface for geodesy to the scientific community and to society in general. GGOS will strive to ensure the stability and ready access to the geometric and gravimetric reference frames by establishing uninterrupted time series of state-of-the-art global observations.

ILRS input to GGOS

The International Laser Ranging Service (ILRS) currently tracks 28 retro-reflector-equipped satellites for geodynamics, remote sensing (altimeter, SAR, etc.), gravity field determination, general relativity, verification of GNSS orbits, and engineering tests (Pearlman et al., 2002). Satellite altitudes range from a few hundreds of kilometers to GPS altitude (20K kilometers) and the Moon. The network includes forty laser ranging stations, two of which routinely range to four targets on the Moon. Satellites are added and deleted from the ILRS tracking roster as new programs are initiated and old programs are completed. The collected data are archived and disseminated via two centers, and several analysis centers voluntarily and routinely deliver products for TRF, EOP, POD, and gravity modeling and development.

Newly designed and implemented laser ranging systems operate semi-autonomously and autonomously at kilohertz frequencies, providing faster satellites acquisition, improved data yield, and extended range capability, at substantially reduced cost. Improved control systems permit much more efficient pass interleaving and new higher resolution event-timers deliver picosecond timing. The higher resolution will make two-wavelength operation for atmospheric refraction delay recovery more practical and applicable for model validation. The current laser ranging network suffers from weak geographic distribution, particularly in Africa and the southern hemisphere. We expect that the GGOS implementation of the comprehensive fundamental network will include additional co-located sites to fill in this gap. Improved satellite retroreflector array designs will reduce uncertainties in center-of-mass corrections, and optical transponders currently under development offer opportunities for extraterrestrial measurements.

Expected advances in instrumentation, as described above, will cause improvements in the TRF and the various products of GGOS, but the accuracy needed for future science applications will require optimization of the ground network. Simulation capabilities within ILRS have been developed and they will allow for evaluation and optimization of the locations of potential sites, as input to GGOS' plans.

In addition, the benefit of introducing a few new SLR targets needs to be evaluated. After decades of SLR missions and great leaps in the principles of analysis of the collected data, we have come to realize that one of the principal limitations in mm-level accurate SLR is target interaction with the current large LAGEOS satellites design, and that only smaller targets would support the necessary accuracy. New lower-altitude targets would allow more observation opportunities per day, increased probability of tracking from lower-power systems (particularly during daylight) and a more accurate determination of Earth's center of mass, critical for both controlling the drift in the origin of the TRF as well as observing the seasonal geocenter motions associated with large-scale mass transport within the Earth system.

We expect that GGOS will act as a strong proponent of these plans, as well as similar plans of the other IAG services, advocating the launch of additional, smaller and better designed SLR targets, that will satisfy the needs of the SLR community and help us deliver better, faster and more frequently our products. GGOS should act as the heavyweight advocate of international geodetic research, seeking agreements and commitments from national space agencies to provide free or cheap launch opportunities as piggyback payloads whenever appropriate launches are scheduled. Cannonball satellites are rather low cost compared to large remote sensing spacecraft, and they can be easily produced with a mass of ~100 kilograms. This can sometimes be a lot less than the leftover margin of a launch vehicle dedicated to a different scientific or commercial launch. If GGOS can intervene and succeed to make such launch opportunities available to the scientific community, it would be fairly easy for ILRS to find the funds and build additional targets that will take advantage of such opportunities. In most cases, these targets can be built at universities and research labs with in-house know-how, keeping the cost to a minimum.

Long Term Planning and Commitment

The measurement techniques services have each maintained their own networks and supporting infrastructure, routinely producing data, but suffer from severe budget constraints of the voluntarily contributing agencies that prevent appropriate maintenance and development of physical and computational assets. This degradation of our capabilities coincides with high value science investigations and missions. These transcend boundaries of scientific disciplines in most cases, for example sea level studies from ocean and ice-sheet altimetry missions, eroding their scientific return and limiting their ability to meet the mission goals. GGOS should ensure our continued support for these, affecting directly the results of GEOSS, although to this day, most of the disciplines contributing to Earth Observations rarely realize how they benefit from our services.

Many components of the services are funded from year to year and depend upon specific activities. Individual components are often financed for capital and maintenance and operations costs through research budgets, which may not constitute a long-term commitment. Sudden changes in funding as priorities and organizations change have resulted in devastating impacts on their products and their performance. On the other hand, missions and long-term projects have assumed that the services will be in place at no cost to them, freely available when their requirements need fulfillment. GGOS needs to be proactive in helping to persuade funding sources that the services are interdependent infrastructure that needs long term, stable support. The GGOS community must secure long-term commitments from sponsoring and contributing agencies for its evolution and operations in order to support its users with high-quality products. In view of the difficulties in securing long-lasting and stable financial support by the interested parties, new financial models must be developed. This must be a high priority goal within GGOS, since everything else depends directly on the success of obtaining secure and stable funding. Furthermore, to avoid interruption of services, data and data products, GGOS should plan for the funding requirements of the future decades well ahead of anything else, factoring into this plan the requirements that each service will determine as necessary in order to meet the goals of GGOS in the future.