IAG dancer : global solutions for all receivers in the world

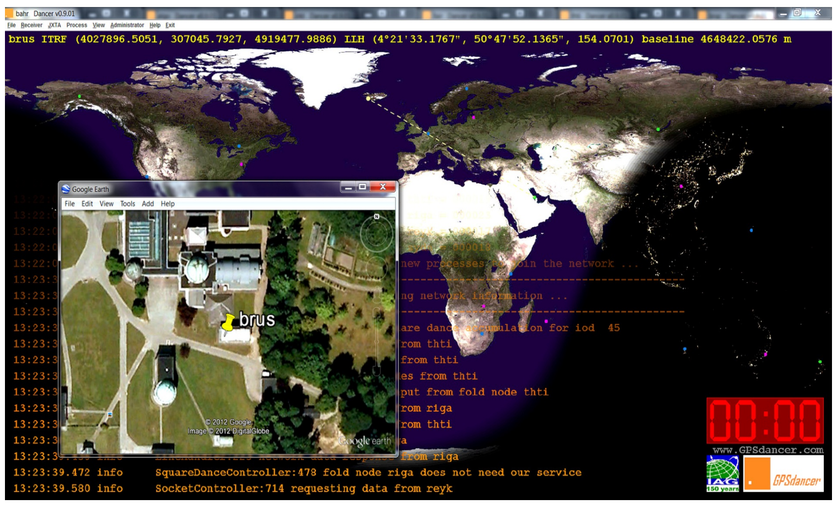
Introduction

This poster presents the status of the GPS Dancer project of IAG WG 1, and includes a call for participation in its on-line validation campaign.

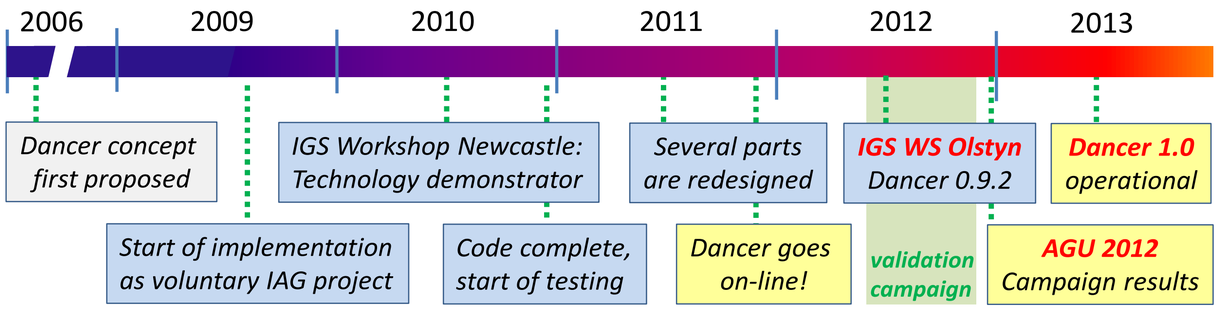
The Dancer project implements a conventional batch least squares estimation process for GPS analysis, in the form of a peer-to-peer scheme on the internet. Each Dancer peer handles the observation data of one single GPS receiver, interacting with the other Dancer processes in the world to solve common satellite orbits, clocks and pole parameters and to resolve phase ambiguities.

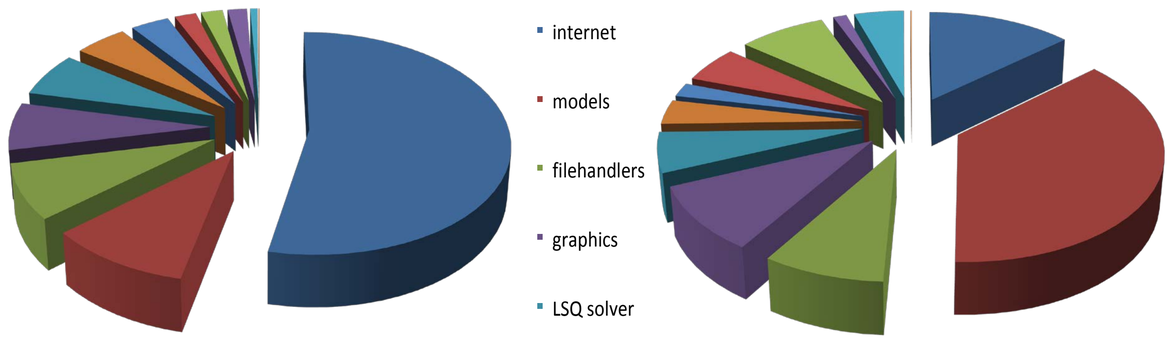
The computational effort for a single receiver is independent of the number of receivers in the network, while the internet traffic for the global solution grows only as a logarithmic function of network size. The current internet is sufficiently powerful to support routine Dancer peer-to-peer solutions among *all* GPS receivers in the world, without any need for central elements such as Data Centres or Analysis Centres.

The mathematics of the distributed least-squares solution behind Dancer were presented on several previous occasions, and are not repeated here. A brief introduction or a background presentation are readily available at request.



Dancer brings the ITRF to your desktop, not only by means of its computation process but also visually. The graphical user interface acts as a clickable KML overlay for Google Earth®, so that you can visit any Dancer station in the world from your own computer. Network operators are encouraged to upload pictures of their installations to Google directly.





Call for participation

If you are interested in the Dancer solution approach and want to help the project forward, please consider taking part in the Dancer validation campaign that will take place between the IGS Workshop and the AGU Fall Meeting 2012.

The validation tests are based on reprocessing of RINEX files, so that you do not need access to an actual GPS receiver. All you need is a computer with JAVA and an internet connection that can be left running with as few interruptions as possible.

Changes in the software or in configuration settings are automatically distributed through the Dancer peer-to-peer network itself, so that your process always remains consistent with the other Dancer processes in the world.

The actual start of the validation campaign will be announced through the IGS mailing list and various similar channels. For further details you can always contact the project via the website at www.GPSdancer.com .

The Dancer JAVA software has been developed by volunteers, because an IAG Working Group has a budget of zero. Dancer is available free of charge from the project website at www.GPSdancer.com.

The most challenging aspect of Dancer was to make the peer-to-peer network self-constructing, self-repairing and even self-optimizing, without having the benefit of a central server.

IGS problem: limited processing capacity

From ~30,000 permanent GPS sites in the world, fewer than 2% have formal ITRF time series. An IGS Analysis Center processes around 300 receivers, at data intervals of 5 minutes and product intervals of six hours. Switching to 30 second data samples for orbiting receivers, and 30 minute products for real-time support augments the workload by a factor 120. A current IGS AC could then only handle three receivers.

Dancer solution: scalable distributed process

A Dancer process is an Analysis Centre for one single receiver. Even at high data rates and product rates its workload remains well below that of an IGS Analysis Center. The solution system is scalable in the number of receivers, so that all receivers in the world can join a single global ITRF realization, at zero running cost.

IGS problem: only published data can be included in the ITRF

Centralized analysis requires the data to travel to the process, as opposed to applying a process to the data wherever it is located. Most network operators cannot publish observation data or local products for valid reasons, such as security or contractual constraints. Today, these receivers remain excluded from the formal ITRF realization.

Dancer solution: anonymous participation

The Dancer least squares solution process only accumulates anonymous lump-sum vectors that can not be reverse-engineered into receiver specific information. This is sufficient for computing precise orbits and other global products, but neither tracking data nor local estimation products need to be shared with third parties.

IGS problem: best effort products

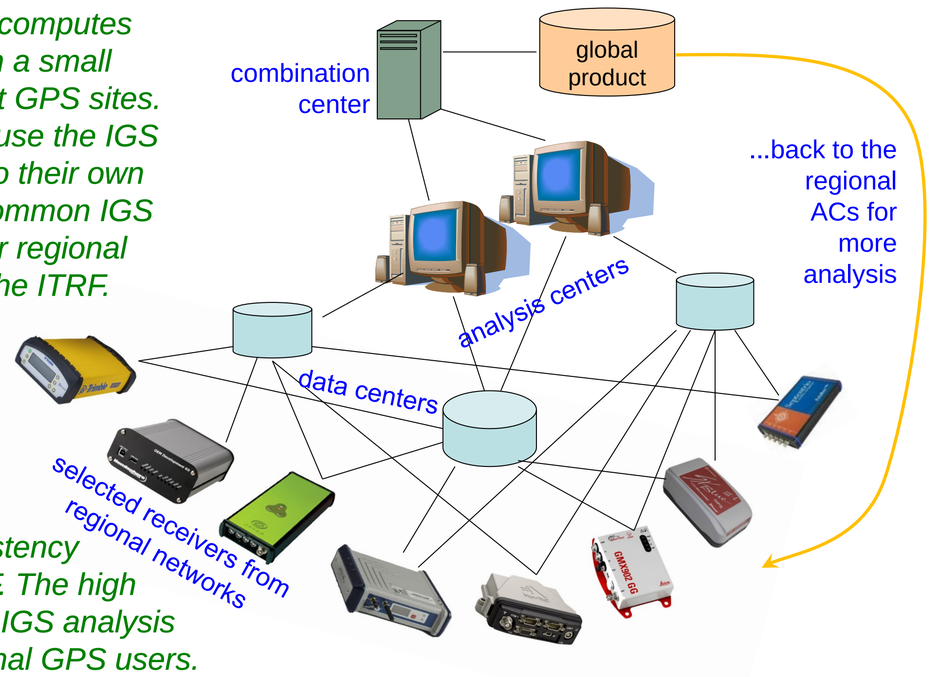
IGS products come without any form of legally binding product assurance or warranty. However, airplanes cannot land on a best effort basis. Serious GPS users today avoid dependencies on unreliable inputs from IGS, and use their own non-ITRF products.

Dancer solution: peer-to-peer only

Dancer is a peer-to-peer system without any central elements. Each global GPS network operator remains autonomous, and can install secure hardware, dedicated internet connections or any other system integrity measures that suit his needs. Each such network merely *communicates with* other networks for long-term reference frame consistency. This is not the same as *depending on* uncertified third party inputs.

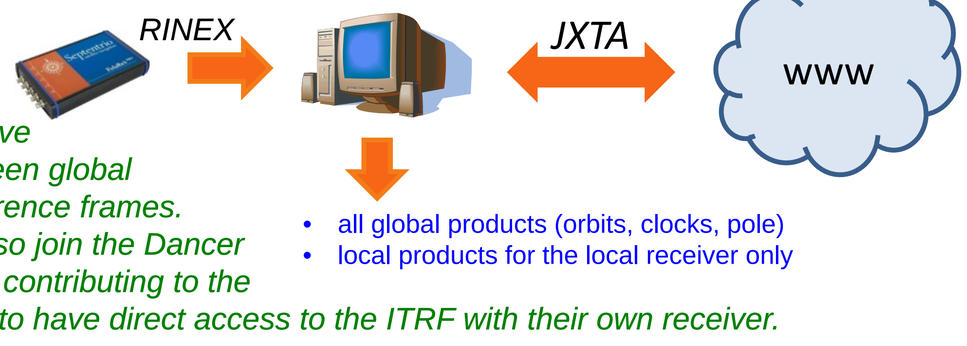
(A) At present, IGS computes global products from a small subset of permanent GPS sites. Regional operators use the IGS products as inputs to their own analysis, and use common IGS stations to align their regional reference frame to the ITRF.

This centralized approach leads to a variety of regional reference frames at different levels of accuracy and consistency with the formal ITRF. The high internal accuracy of IGS analysis does not reach normal GPS users.



(B) IAG Dancer will initially be available as JAVA desktop application only. Any permanent site in the world can run the software (for free!) on a local computer to become part of the global solution process.

The unlimited network size of Dancer can remove distinctions between global and regional reference frames. End-users can also join the Dancer network - without contributing to the global products - to have direct access to the ITRF with their own receiver.



(C) If manufacturers augment the processing capacity of receivers to the level of - for instance - a modern smart phone, future GPS receivers can run embedded Dancer processes immediately. This leads to the concept of "smart receivers" that produce all relevant estimation products immediately, in a way that is fully consistent with the ITRF - anywhere on Earth.

Future plans also include

- *extensions to other GNSS systems than GPS*
- *inclusion of other geodetic data types (notably VLBI)*
- *A long-arc / reprocessing version (**DIGGER**)*
- *A real-time kinematic interface (**DART**)*

precise geodetic products directly from a *smart receiver*

For more information: www.GPSdancer.com
IAG Working Group 1.1.1
JXTA community projects jxta.dev.java.net

E-mail contact@GPSdancer.com

For further details on algorithms and project context see also H. Boomkamp, *Global GPS reference frame solutions of unlimited size*, Adv. Space Res. Vol 46, issue 2, 15 July 2010 pp 136-143 SI GNSS Remote Sensing-1

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