Suggested Guidance

for

OPUS Projects Processing

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Guiding Principles

Let's review some of the material from the background discussion which we'll call our Guiding Principles.

Guiding Principle - 1

- Precision is independent of baseline length

  The accuracy of the IGS orbits, the ionosphere-free combination of the phase data, and the modeling of the troposphere essentially remove these effects as a function of baseline length.

Guiding Principle - 2

- Precision depends on observation span

  More data means better phase bias determination leading to better integer-fixing, more multipath averaging, better troposphere solutions and better coordinate precision.

Guiding Principle - 3

- Session network designs must include both short and long baseline lengths

  Short baselines optimize amount of observations by mutual visibility of the satellites and long baselines are needed to decorrelate the tropospheric adjustments on the short baselines.

Guiding Principle - 4

- GNSS measurement errors are independent, they do not propagate through a network

  GPS measurements are not like total station measurements and there are no inherent connections between the receivers in a project.

Guiding Principle - 5

- Relative positions must be with respect to a single reference mark or reference network

  The relative positions of project marks should take advantage of common-mode errors, connect to the same Hub and not introduce chains of dependencies that are not inherent in the measurements.

Basic OPUS Projects Options

- Network design
- Hub mark selections
- Tropospheric modeling
- Included CORS
- Constraints

Network Design

- Each session requires that baselines be defined.
  - Baselines are defined by selecting Hub marks.
  - Every mark that is not a Hub tries to connect directly to Hub.
- Only 1 Hub per session. Make the Hub a CORS if at all possible.
- Rover positions are relative to constrained marks.

Hub mark Selection

- Minimize observations lost to the need for mutual visibility by keeping the distance to the Hub < ~100 km.
- To meet the previous requirement, spatially large projects might require different Hubs be used in different sessions.
- All Hubs should be present in all sessions.

Troposphere Modeling

- Model style can be either Step-offsets (SO) between intervals or Piecewise Linear (PWL).
  - In the spirit of avoiding discrete steps transitioning from one tropo interval to the next, PWL troposphere adjustments are preferred - nature does not move in discrete steps.
- Troposphere correction intervals.
  - Adjustment interval may depend on local conditions, but, generally, 7200 sec is preferred (which is equivalent to 2×3600 sec intervals but without the discrete step).

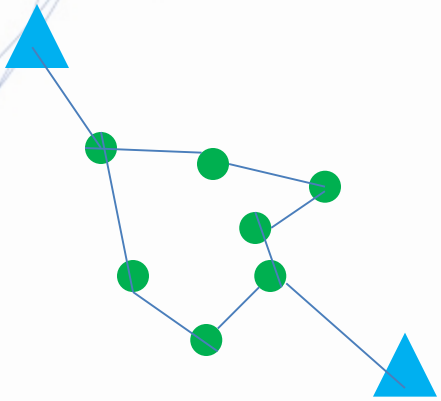
Included CORS

- Only one, or a few at most, CORS will be Hubs.
- Distant CORS must be included in all sessions for troposphere decorrelation.
- The included CORS, particularly those used as Hubs, should be present in all sessions.
- Although it is not necessary to use all CORS uploaded by OPUS, more included CORS implies less dependence on a single CORS and a better tie to the NSRS.

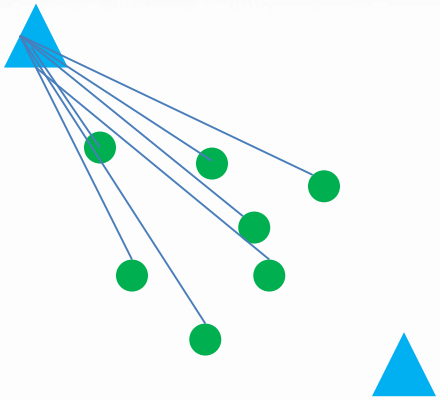
Constraint Weight

- The choice is almost always between Tight or Normal constraint weight for the CORS.
- Many CORS display seasonal motion which makes Tight constraint weight suboptimal.
- Many CORS have poor velocities which makes Tight constraint weight suboptimal .
- Because multiple CORS will always be used (at least 1 Hub + 1 distant CORS), Normal constraint weight seems preferred.

Example 1: Connect marks directly to Hubs.



No

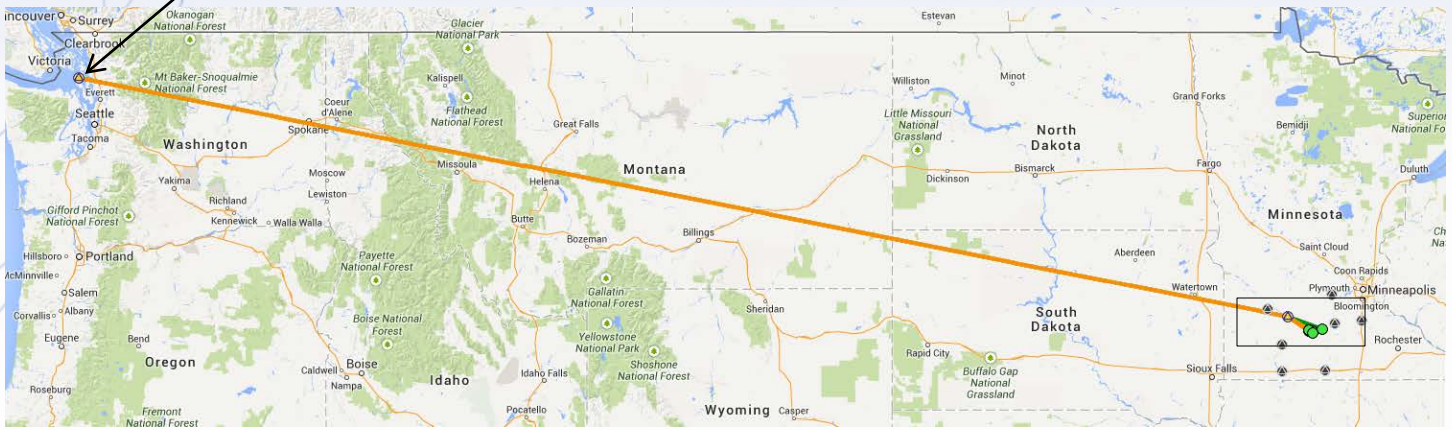


Yes

Example 2: Create a single reference network.

Example 3: A single Hub example.

Distant CORS for
tropo decorrelation



Only this CORS is
designated Hub

Hub Selection

- Do not connect a project mark with just a few hours of data to distant CORS (too few mutual observations).
- Take advantage of their continuous data collection by using CORS as Hub(s).

Network Components

- Think of project as having 2 components:
- Local network
  - Think precision - get best relative positions.
- Reference network
  - Think accuracy - multiple CORS tie the local network into NSRS.

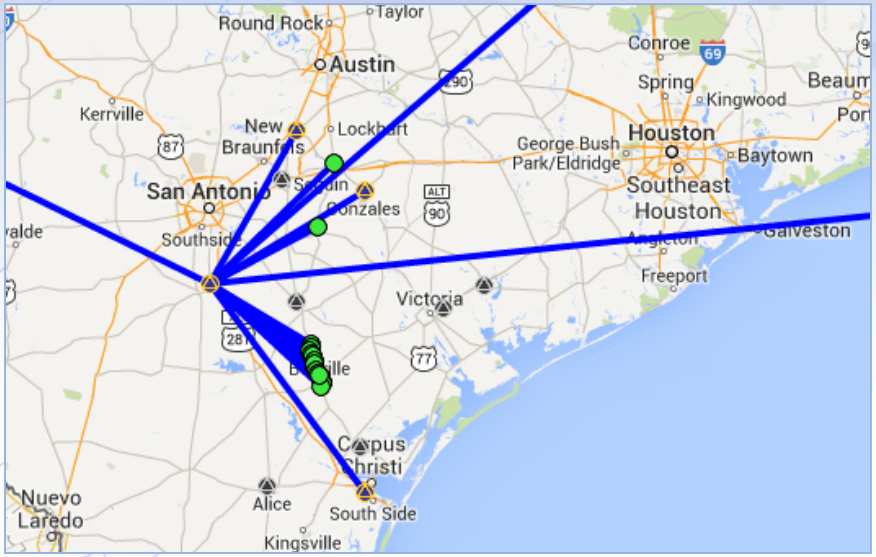
Local Network

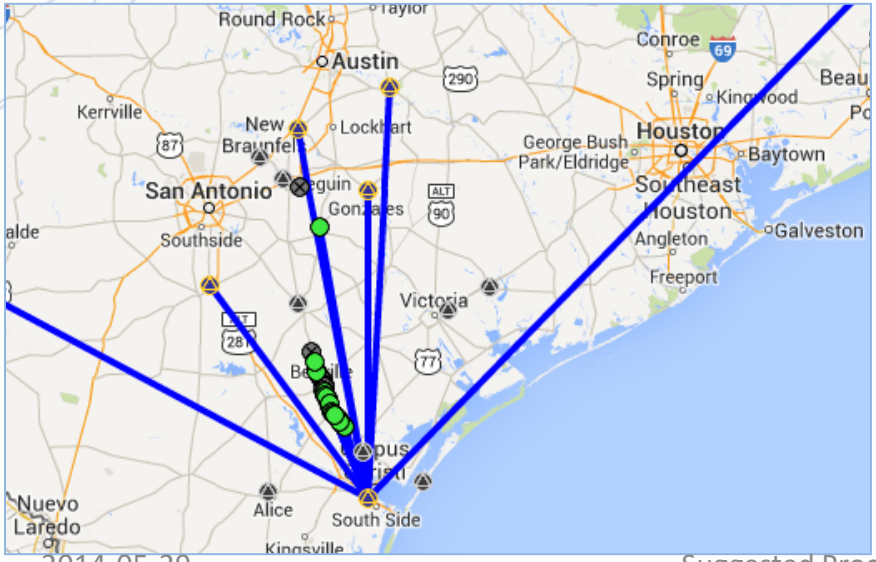
- Think precision - get best relative positions:
  - Use common-mode errors to your advantage.
  - Use identical antennas when possible.
  - Keep baselines short maximizing simultaneous observations.
  - Use a single Hub per session.
  - Use the same Hub for all sessions when possible.
  - Include at least one distant CORS to stabilize tropo corrections.
  - Normal constraints.

Reference Network

- Think accuracy - multiple CORS tie the local network into NSRS:
  - Include the Hub(s) and distant CORS in all sessions.
  - Multiple CORS remove single reference mark bias.
  - Normal constraint weights allow for small variations in positions typical of CORS or any mark.

Example 4: Multiple Hub example.



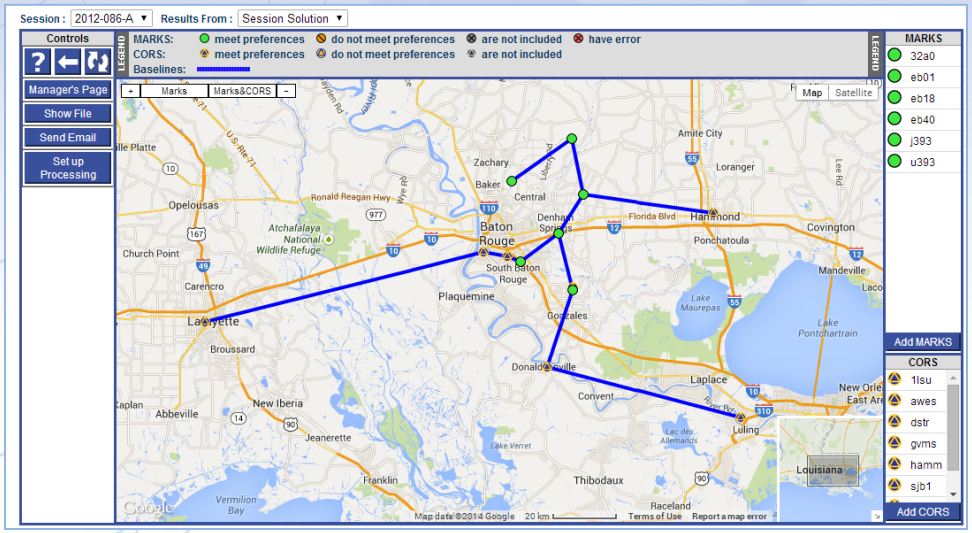


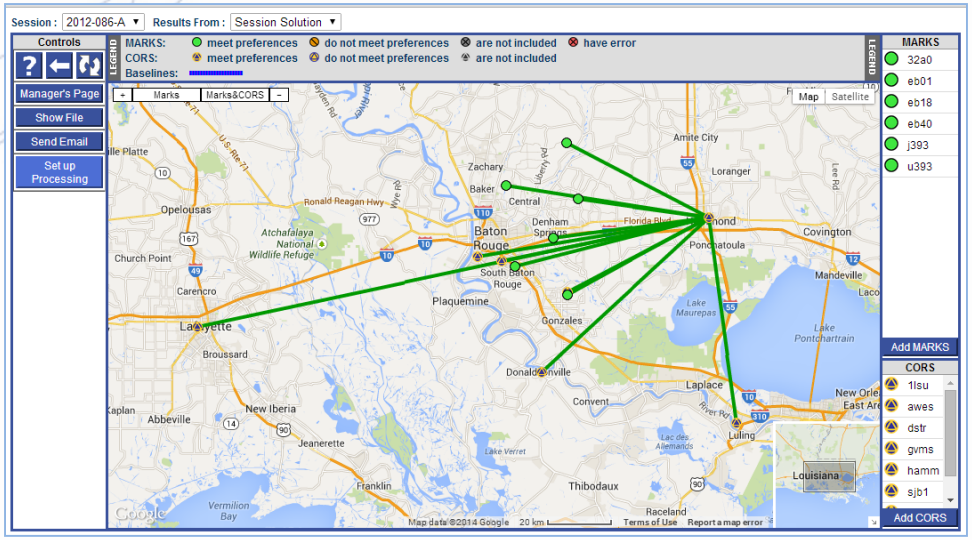
GSVS2011: The survey used a limited number of receivers to from Austin to Corpus Christi. This distance required that multiple hubs be used to minimize data lost to mutual visibility.

- Marks used as Hubs were included in all sessions.
- Each session's Hub connects to all marks in the session including all marks used as Hubs in other sessions.
- Distant marks connect to the session's Hub.

Result: Consistent relative positions for project marks. All CORS contribute to aligning the project to the NSRS.

Example 5: Same project, two designs.



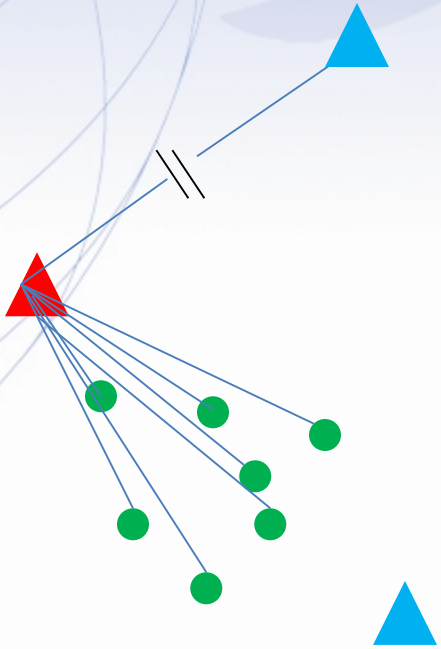


Can you identify the advantages and disadvantages of these two network designs?

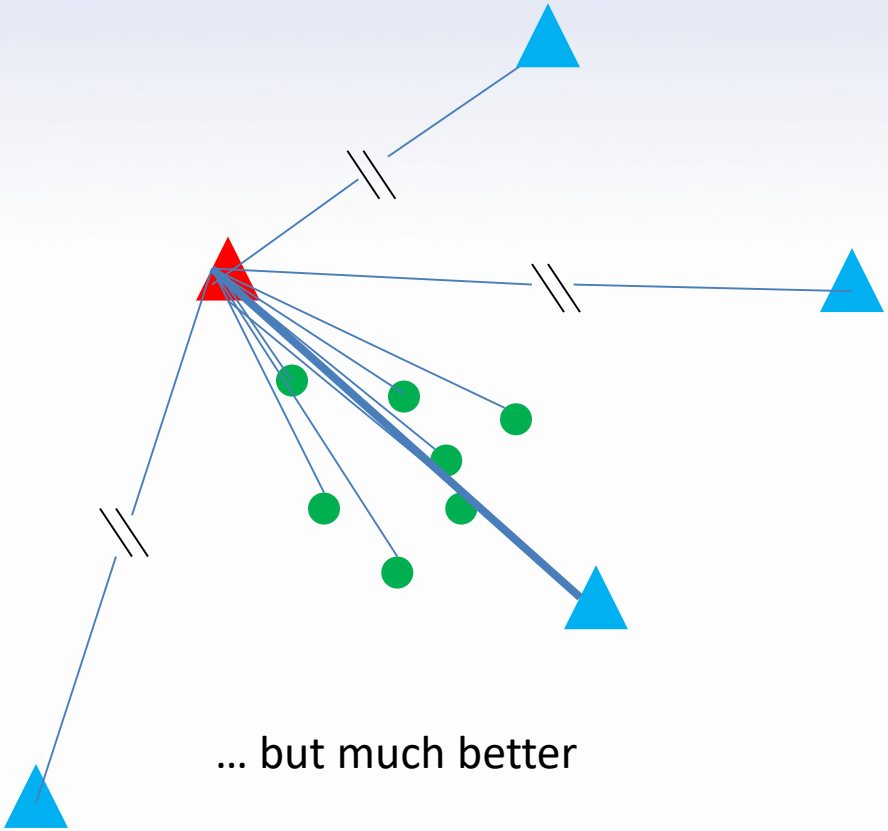
What About A Project Hub?

- Project Hub = a mark specifically occupied to act as a Hub for a project. This implies you've planned ahead and recognized that there is no suitable CORS. Good!
- Project Hubs are used similarly to CORS Hubs:
  - Use one project Hub if at all possible.
  - Project Hubs appear in all sessions.
  - A project Hub's occupation must span its entire session.
  - A project Hub's occupation must sufficient to remedy mutual visibility data loss to the more distant CORS.
- Because project Hub are unconstrained, sessions should include multiple local and/or distant CORS to better tie the project Hub into the NSRS.

Example 6: Single project Hub



Not too bad …



… but much better

Quick Summary

- At Project Level
  - Add all selected distant CORS.
  - Add all selected hubs to each session if necessary.
  - Select PWL, 7200 Tropo.
  - Select Normal constraint weighting.
  - Select Network Design: User
- At Session Level
  - Select 1 Hub.
  - Include all Hubs from other sessions, if any, (but do not designate as Hubs)
  - Include all distant marks.
  - Omit unused CORS.
  - Constrained CORS only.

Last Advice

- Think about how you'll process the data before you take the data.
- Let the data tell you the position, not the Data Base.