IGS RINEX 3 Transition Plan v3.0

IGS Infrastructure Committee, Rinex Working Group, Multi-GNSS Experiment.

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1. Introduction

This RINEX 3 transition plan aims at consolidating the developments and the evolution within the IGS to ensure the final agreed goal of the IGS 2014 Workshop; "**one network and one archive**"

The acceptance by the IGS in 2012 of the RINEX 3 (Rx3) as the only GNSS data exchange format moving forward, and the positive progress of the MGEX (Multi-GNSS Experiment) mean that we need to start to integrate all the data sources into the common IGS data repositories. The adoption of the RINEX standard means that **new station names** and **new data file filenames** will be introduced. So far only the new RINEX 3 file formats have been utilized, as the MGEX retained the short RINEX 2 (Rx2) filenames for the new RINEX 3 data files to avoid too much initial confusion, but this was only a temporary measure.

At the 2014 IGS Workshop it has been agreed to **assume the whole RINEX 3 standard** (ftp://igs.org/pub/data/format/rinex302.pdf) including the new station identifiers and data file filenames. This requires a plan to be able to have a smooth transition from data providers to published results. This plan recognizes that we will have to live with the **RINEX 2.11 and RINEX 3 duality** for a long time since many legacy stations will not be able to produce RINEX 3 files from older receivers. Analysis Centers need to modify their software to be able to use the Rx3 files with the long filenames. Also generic GNSS data users may want to use the upgraded station's data even if they cannot read the new Rx3 format and a solution is needed for them by providing a Rx3 -> Rx2 down-converter.

The initial step is to make the data in RINEX 3 with correct long filenames available to the GNSS community in the expected locations (no more special 'campaign' directory for Rx3 data). It is possible to do this without confusion since files will not overwrite each other using the new Rx3 filenames, but we need to ensure that this does not cause problems to existing Rx2 data users accustomed to the standard filenames, and that Data Centers can manage the new files correctly.

The Figure 1 below gives an overview of the Rx3 effects, and the responsible parties for the transition.
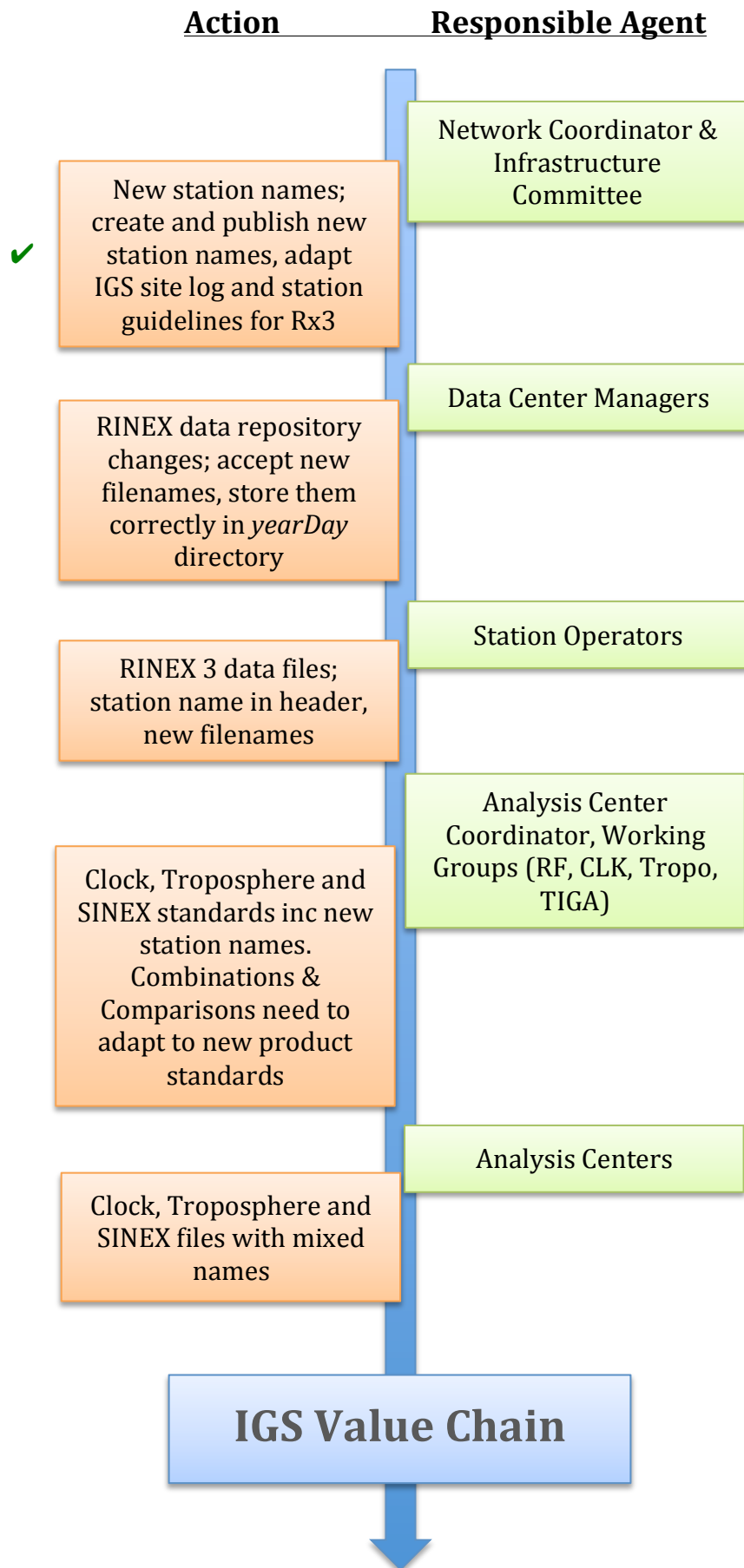
Action   **Responsible Agent**

Network Coordinator & Infrastructure Committee

✔ New station names; create and publish new station names, adapt IGS site log and station guidelines for Rx3

Data Center Managers

RINEX data repository changes; accept new filenames, store them correctly in *yearDay* directory

Station Operators

RINEX 3 data files; station name in header, new filenames

Analysis Center Coordinator, Working Groups (RF, CLK, Tropo, TIGA)

Clock, Troposphere and SINEX standards inc new station names. Combinations & Comparisons need to adapt to new product standards

Analysis Centers

Clock, Troposphere and SINEX files with mixed names

IGS Value Chain

Figure 1: IGS Value Chain

RINEX 3 has been adopted as an IGS standard in 2012, and the IGS needs to move forward with its adoption in a decisive way. RINEX 2.11 (http://igscb.jpl.nasa.gov/igscb/data/format/rinex211.txt) will be the last legacy Rx2 format as agreed in the 'IGS/RTCM RINEX Working Group', any past reference to a possible RINEX 2.12 or a RINEX 2.30 are no longer valid. It is recognized that Rx2 files will remain around for many legacy stations and applications that use the limited constellations and signals defined therein. On the other hand future developments need to accommodate the evolving GNSS constellations and signals will only be made in the RINEX 3 standard.

It is well understood that station operators and network managers, who can only operate using the RINEX 2.11 format will do so and continue to be an integral part of the IGS. Station operators who operate up to date multi-GNSS receivers are encouraged to update their software and procedures and provide fully compliant multi-GNSS Rx3 files. This document provides a non-redundant and straight forward way to do so within the mainstream IGS, thus ensuring that **future development in GNSS continues to be led by the IGS**.

The sections below explain the necessary steps as listed in Figure 1, and they follow the IGS Value Chain. Many of the steps can be performed in parallel, as format changes will have their own review and acceptance cycles, which do not necessarily depend on other steps being completed.

2. Preparatory Tasks (NC, IC)

The RINEX 3 standard introduces **new station names**, thus the first step of the transition is for the Network Coordinator (NC) and Infrastructure Committee (IC) to make available the new station names for all the IGS network stations. The new filenames together with their traditional four character IDs will be published on the IGS website in a flat text file.

It is essential to note that the full station and filename accommodations affect the entire GNSS processing chain and beyond. It is crucial that, to avoid any possible confusion, the **new station names will be constructed centrally by the IGS CB**. The new station names are still backwards compatible by removing the last 5 characters, which are the monument number, receiver number and country code, e.g; **mas1**
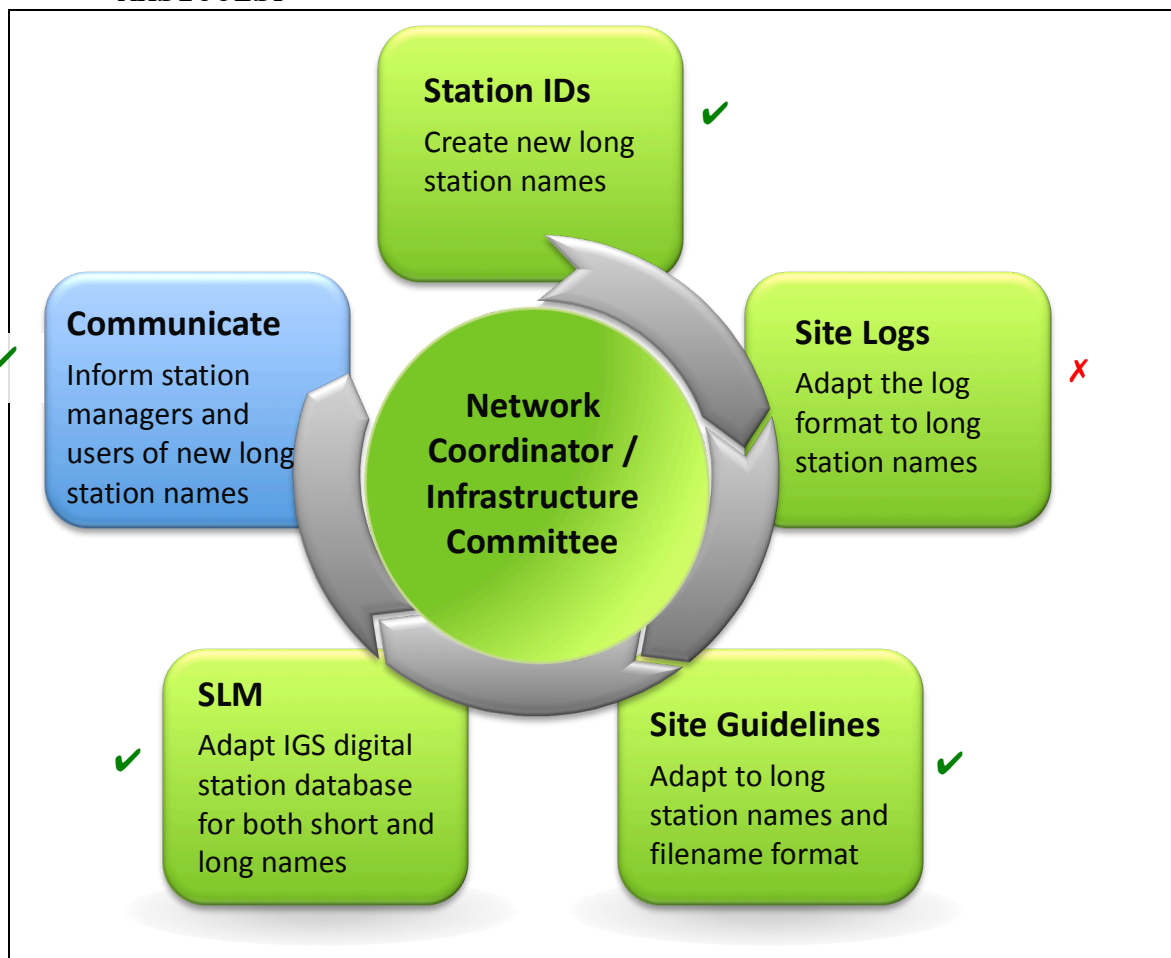
MAS100ESP

Figure 2: Rx 3 Transition Preparatory Tasks (Completed)

The station naming backward compatibility will have to be ensured for at least 3 years (TBC). At some point though it will occur that a station with the same 4 char ID will appear in a different country (i.e.- MAS100DEU), but we need a significant amount of time to manage this situation and an active Network Coordination to ensure no problems.   Therefore for the time being the long station names (a9) will be constructed from the original 4-character ID.

In parallel, both the **site log form** and the **IGS station information database (SLM)** need to be revised to accommodate the new station names and anything else needed. Additionally the **IGS station guidelines** will need to be revised to include the new long station names, and to ensure that IGS network stations can provide Rx2 and/or Rx3 files. **Update**: The IGS site logs will not be updated to include the station long names; these names are now available in the station information systems such as the IGS SLM and the EPN system. Since the new long names are constructed unequivocally from the 4 character IDs it is not necessary to state them again in the station logs.

Station Operators and Station Network Managers will be informed of the parallel designation of their stations by pointing them to a central location (i.e. the IGS station network page), where they can find the new official Rx3 and long station file names.

Also to be handled at this time is the adaptation of the '*igs.snx'* file generated by the NC to accumulate most of the station's metadata now. The inclusion of the new names will have to be managed in the '*igs.snx*', which is closely related to the needed SINEX changes discussed below (section 5.2).

The ACC has made available two Rinex down-converters on the IGS ACC website; one generated by O. Colombo, and one by GFZ (***gfzrnx***).

3. Data Center Tasks (DCs)

Data Centers (DCs) need to prepare to **accept GNSS data files** with the new filenames, to uncompress them, check they are Rx3 files, check the file size is reasonable and store them in the correct *yearDay* directory of the public data server and perform basic data QC. **Update**: the GFZ tool made available through the IGS ACC webpage (*gfzrnx*) can provide the basic QC and renaming features needed by the Data Centers to handle the Rinex 3 files.

Additionally DCs that gather real-time observation and navigation data streams need to write Rx3 files from the streams with the correct long names. Finally the DCs need to be prepared to store some products with new long filenames, such as the tropo products, which are separated 'by station'.
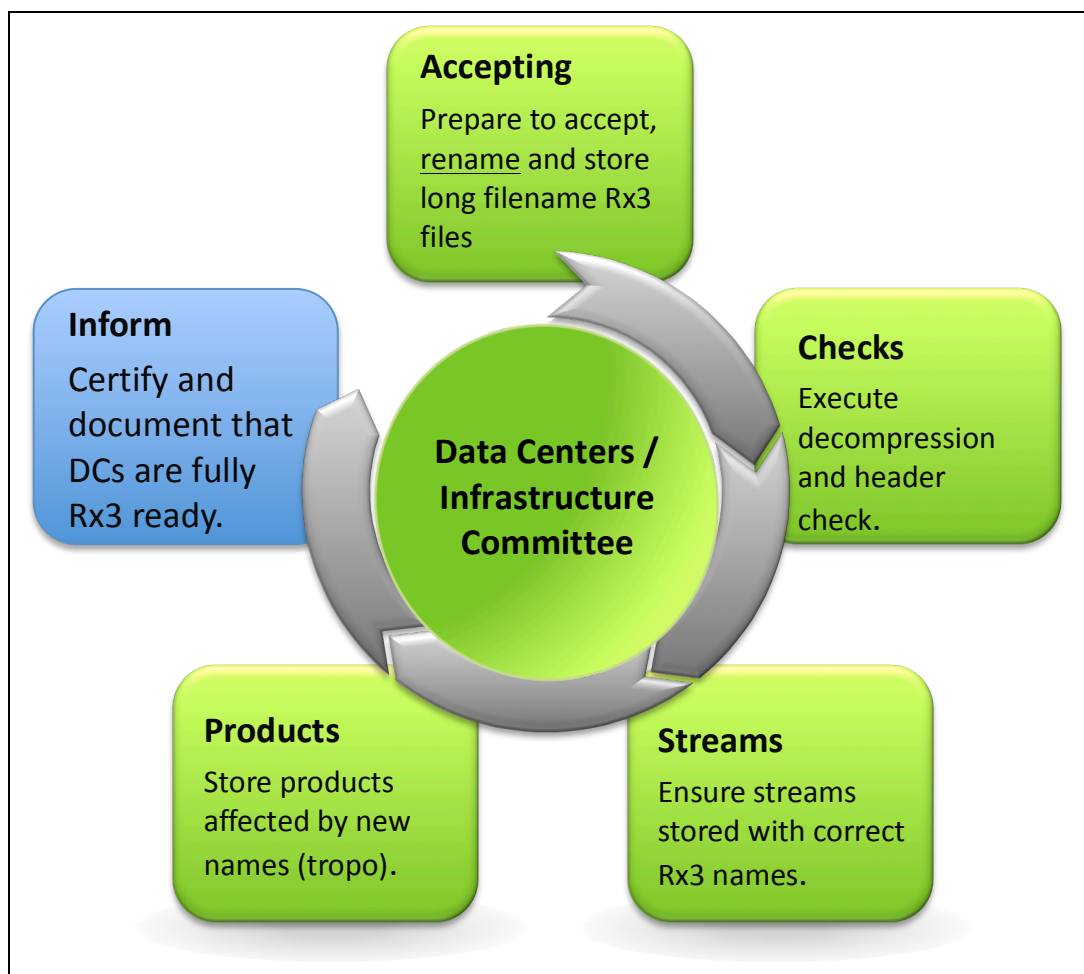
Accepting
Prepare to accept, <u>rename</u> and store long filename Rx3 files

Checks
Execute decompression and header check.

Data Centers / Infrastructure Committee

Inform
Certify and document that DCs are fully Rx3 ready.

Products
Store products affected by new names (tropo).

Streams
Ensure streams stored with correct Rx3 names.

Figure 3: Rx3 Data Center Transition Tasks

Rx3 files using long names are delivered using *gzip* compression, finally moving away from the old UNIX compress.

The Rx3 long filenames are fully described in the latest Rx3 format definition: ftp://igs.org/pub/data/format/rinex302.pdf , some examples are shown below.

For **daily** Rx3 files we currently have in the *campaign/mgex/daily* directory:

mas12350.14d.Z

which becomes, with the Rx3 long names;

MAS100ESP_R_20142350000_01D_30S_MO.crx.gz

to be stored together with the Rinex 2 daily files (i.e. in the CDDIS server in the 15d/, 15n/ directories).

For **hourly** Rx3 files we currently have in *campaign/mgex/hourly* directory;

cebr240b.14d.Z

which becomes, with the Rx3 long names;

CEBR00ESP_R_20142400100_01H_30S_MO.crx.gz

to be stored together with the Rinex 2 hourly files (i.e. in the CDDIS server in the 15d/, 15n/ directories).

For **high-rate** Rx3 files we currently have in *campaign/mgex/highrate* directory;

faa1245c30.14d.Z

which becomes, with the Rx3 long names;

FAA100PYF_R_20142450230_15M_01S_MO.crx.gz

to be stored together with the Rinex 2 15 minute files (i.e. in the CDDIS server in the 15d/, 15n/ directories).

Update: The name of the subdirectories will have to be changed in one year (TBC) from *15d/*, *15n/*, etc to *obs/* , *nav/*, *met/*, etc. That is for the Data Centers that use such data storage directory names. Additionally navigation files moving forward should be 'merged' as much as possible; rather than one navigation file per station

per GNSS constellation we need to get one navigation file per station for all the constellation per reporting period (as for the observations). This would then cut down on the number of files in the future *nav*/ directory.

The contents of all equivalent files above are exactly the same, it is only the filename that changes. The DCs need to ensure that the new filenames get stored properly in the regular data repository directories (no longer in *campaign* directories!). The new names indicate the start of the data, the length of the file, the frequency of the data inside the file, the type of data (i.e.- MO – Mixed Observations), and the compression methods; *crx* for Hatanaka compressed, and *gz.*

The DCs should accept Rinex 3 files with the new long names, the station operators generate the names and they could be symbolic names or realistic names. The storage policy in the DCs shall remain as now, not tolerating deviations in terms of the different file types; 15 min 1 Hz files, 30 sec 1 hour files and 24 hour 30 second files. Therefore we shall continue to not accept 1Hz files longer than 15 min. 30 second files shorter than one hour shall be stored with the corresponding Hourly files, and 30-second files longer than 1 hour shall be stored with the corresponding Daily files.

No files longer than one day or with data spans over a day boundary shall be accepted for the repositories, even though the new RINEX 3 long filenames can obviously accommodate such files that flexibility is good for RINEX as a standard but not for the storage of data files in the Data Centers.

Update: Data Centers should rename and move existing Rinex 3 files to the new long names from the *campaign/mgex* directory to the regular repository moving backwards from 2015. This renaming activity shall be well coordinated by the DC WG so that different renaming and equalization activities do not overwrite files or create duplicate files.

As for streamed data most Data Centers that accumulate streams into high-rate RINEX files do so using station header skeleton files and the short filenames. These skeleton files and associated applications will have to be adapted, since writing RINEX 3 files will now require the new long filenames.

With the help of the NC and IC the Data Centers will need to engage the maintainers of other supporting software such as BNC to ensure they can support the new long names.

4. Station Managers/Station Operators Tasks

Stations Managers/Station Operators (SOs) are generally directly in charge of their own station's data flows and they should be given the necessary indications and instructions to generate RINEX 3 files correctly and which are properly named. The file flow of **existing RINEX 3 station files will be in parallel using the two different names for 6 months maximum**. The RINEX 3 file arriving with the short names will continue to be stored in the *campaign/mgex* directory, and the file with the new long filenames would be merged into the regular *gps/data/[daily|hourly|highrate]* directory.

Therefore, Station Operators with existing RINEX 3 data files will be directed to continue to submit their files using the short naming scheme, as they do now, to be stored in the '*mgex*' campaign directory for a few months, plus to add a second submission using the new long names for storage in the regular RINEX data repository. After the six-month trial period the RINEX 3 files with the short names will be discontinued.

The Rinex 2 files from each station can be submitted in parallel to the Rinex 3 files for a period of up to a year (TBC).

For streaming data the situation remains as it is, but RINEX 3 high-rate files collected from streams need to use the new long naming scheme ensuring the "data file source parameter" in the long names is correct ('R' for files derived from receiver outputs, 'S' for files from streams, 'U' for unknown origin). RINEX 2 high-rate files will stay as they are.

The tool generated by GFZ (*gfzrnx*) can be used to rename RINEX 3 files to the long names based on their current short names. The entity doing the renaming should be agreed between the station operator and its primary Data Center.

5   Analysis Coordinators and Combiner Tasks

It is the responsibility of the ACC and the different Working Group Coordinators (Tropo, Reference Frame, IERS WG on SINEX format, Clock, etc) to **change (or propose and promote) the product formats as needed to accommodate the new station names**. We need to ensure that the products as presented below are properly addressed.
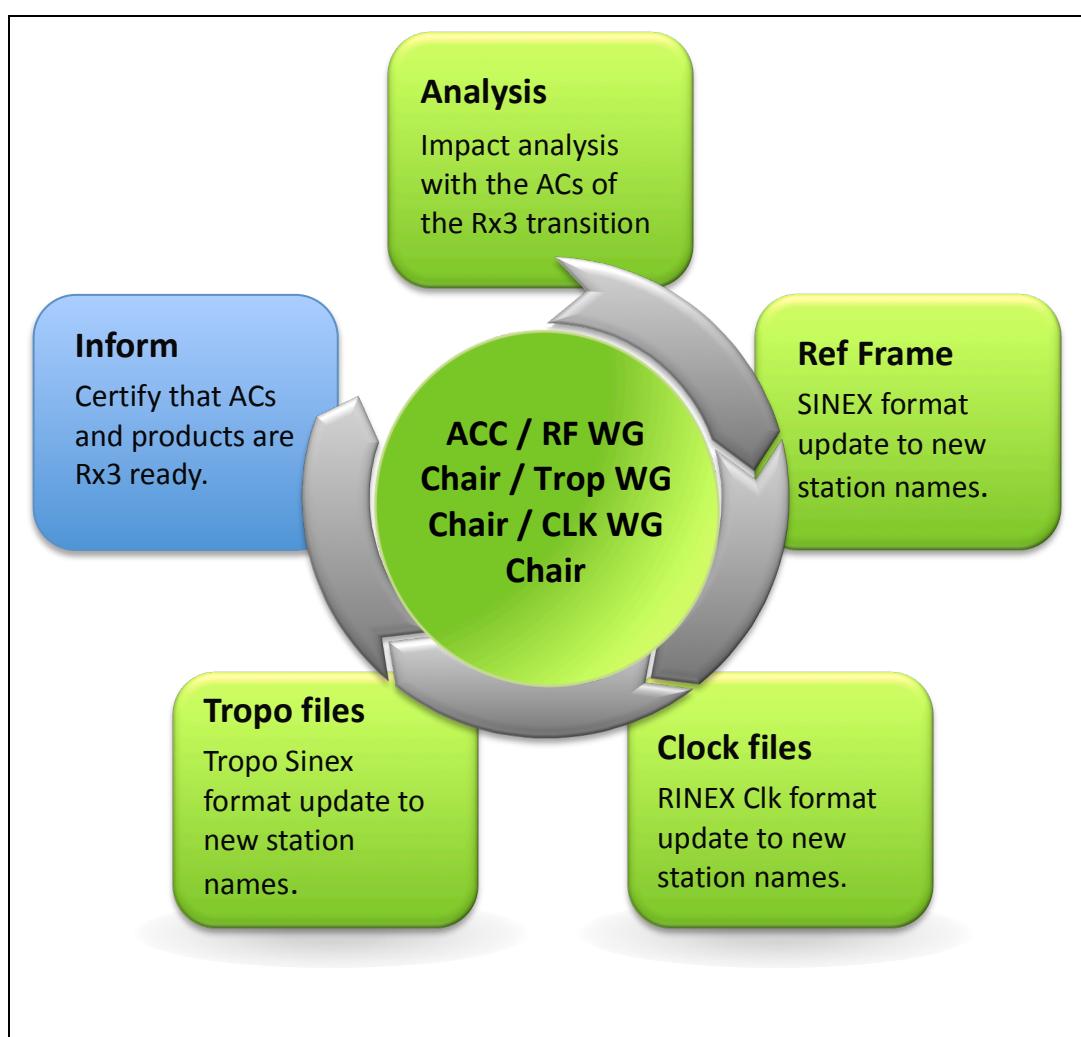

Figure 4: Analysis Coordinators and Working Group Tasks

Below is a preliminary list of the products that need to be addressed and a possible way forward.

5.1 RINEX Clock files

Only format issues need to be corrected (not product filenaming), for example;

```
From this;
MAL2 33201M003              4865385527  4110717376  -331137462SOLN STA NAME / NUM
MAS1 31303M002              5439192171 -1522055306  2953454994SOLN STA NAME / NUM
MIZU 21702M002             -3857170474  3108693106  4004040330SOLN STA NAME / NUM
NNOR 50181M001             -2414152121  4907778579 -3270644465SOLN STA NAME / NUM
…
AR MAL2 2014 08 27 00 00  0.000000  2  -1.415334749625e-04  2.098948497020e-11
AR MAS1 2014 08 27 00 00  0.000000  2  -1.141963785165e-04  3.230665580340e-11
AR MIZU 2014 08 27 00 00  0.000000  2  -8.119328887498e-07  6.860250726770e-11
AR NNOR 2014 08 27 00 00  0.000000  2  -2.585933960805e-04  3.747723307230e-11
```

```
To this;
MAL200KEN 33201M003            4865385527  4110717376  -331137462SOLN STA NAME / NUM
MAS100ESP 31303M002            5439192171 -1522055306  2953454994SOLN STA NAME / NUM
MIZU00JAP 21702M002           -3857170474  3108693106  4004040330SOLN STA NAME / NUM
NNOR00AUS 50181M001           -2414152121  4907778579 -3270644465SOLN STA NAME / NUM
…
AR MAL200KEN 2014 08 27 00 00  0.000000  2  -1.415334749625e-04  2.098948497020e-11
AR MAS100ESP 2014 08 27 00 00  0.000000  2  -1.141963785165e-04  3.230665580340e-11
AR MIZU00JAP 2014 08 27 00 00  0.000000  2  -8.119328887498e-07  6.860250726770e-11
AR NNOR00AUS 2014 08 27 00 00  0.000000  2  -2.585933960805e-04  3.747723307230e-11
…
```

As this format is under the direct control of the IGS Clock Working Group it should be possible to propose and promote the update of the format.

5.2 SINEX stations position files

Internal format changes needed to accommodate the new station names, in the SITE/ID, SITE/ANTENNA, SITE/ECCENTRICITY, SOLUTION/EPOCHS, SOLUTION/ESTIMATE , SOLUTION/APRIORI blocks, assuming the 80 column limit can be removed we would increase the SITE designation to an "a9", thus we could for example have ;

```
From this;
+SITE/ID
*CODE PT DOMES____ T STATION_DESCRIPTION___ APPROX_LON_ APPROX_LAT_ _APP_H_
 CEBR  A 13408M001 P CEBREROS, Spain        355 37 55.7  40 27 12.3   776.4
…
+SOLUTION/ESTIMATE
*INDEX TYPE__ CODE PT SOLN _REF_EPOCH__ UNIT S __ESTIMATED_VALUE____ _STD_DEV___
   244 STAX   CEBR A    1 14:228:43184 m    2 0.484666487763101E+07 .266990E-02
   245 STAY   CEBR A    1 14:228:43184 m    2 -.370195106795309E+06 .103238E-02
   246 STAZ   CEBR A    1 14:228:43184 m    2 0.411692957563304E+07 .222837E-02
```

```
…
To this;
+SITE/ID
*CODE       PT DOMES____  T STATION_DESCRIPTION___  APPROX_LON_ APPROX_LAT_ _APP_H_
 CEBR00ESP  A 13408M001 P CEBREROS, Spain          355 37 55.7  40 27 12.3   776.4
…
+SOLUTION/ESTIMATE
*INDEX TYPE__ CODE       PT SOLN _REF_EPOCH__ UNIT S __ESTIMATED_VALUE____ _STD_DEV___
   244 STAX   CEBR00ESP  A    1 14:228:43184 m    2 0.484666487763101E+07 .266990E-02
   245 STAY   CEBR00ESP  A    1 14:228:43184 m    2 -.370195106795309E+06 .103238E-02
   246 STAZ   CEBR00ESP  A    1 14:228:43184 m    2 0.411692957563304E+07 .222837E-02
…
```

In this proposal mixing short and long names would be possible inside the same solution file for stations that only submit Rx2 data files, or only Rx3 data files.

It could also be possible to create a new SINEX block for naming equivalency, but that may be more complicated, and probably not recommended.

Any SINEX change needs to be brought up at the IERS by the ACC and the RF Working Group Chair to D. Thaller in the IERS Working Group on SINEX Format. On the other hand the 'a4' station names can continue to be used for the time being, and in SINEX the 4 char ID together with the DOMES numbers make for unique identifiers.

Hopefully changing 'a4' to 'a9' is not a big change, it needs to be managed carefully under the Governing Board's supervision.

5.3   Tropo files

As with the SINEX format, from which Tropo derives, almost all the SITE blocks are affected in the Tropo format. Also the filenames will need to be changed as the IGS Tropo files use the 4-character ID as part of the individual station tropo estimation files.

```
From this;
+TROP/SOLUTION
*SITE EPOCH_____   TROTOT STDEV  TGNTOT  STDEV  TGETOT  STDEV
 MAS1 13:150:00000 2539.4   2.8  -3.106  0.407   0.059  0.474
…
Using filename;
mas1150.13zpd
```
```
To this;
+TROP/SOLUTION
*SITE       EPOCH_____   TROTOT STDEV  TGNTOT  STDEV  TGETOT  STDEV
 MAS100ESP 13:150:00000 2539.4   2.8  -3.106  0.407   0.059  0.474
…
To using filename;
MAS100ESP150.13zpd
```

There is a new Tropo Format Working Group chaired by R. Pacione proposing a new format and considering the new station designations.

5.4   Bias Format

Derived from the SINEX this format quantifies the station and satellite biases for the different signals (http://www.biasws2012.unibe.ch/docs/sinex_bias_0.01-2.txt). As this is an IGS format derived between the MGEX and Bias Working Group, it is not considered a big hurdle, as it can be handled internally in the IGS.

6. Timeline

A Gantt chart titled "Rx3 Transition" spanning Dec '14 through Jun '15 with the following tasks:

- 1.0 Preparatory Tasks by NC and IC
- 1.1 New Rx3 station names
- 1.2 Update Site Log form
- 1.3 Update Guidelines
- 2.0 Data Center Tasks
- 2.1 Data Repository Changes
- 3.0 Station Managers/Operator Tasks
- 4.0 Analysis Coord and Combination Tasks