GOOGLE SUMMER OF CODE - 2015 (GSOC '15)

METADATA STANDARDIZATION

SUMMARY:

- Over the last decade, there has been a rapid evolution in the Global Navigation Satellite System (GNSS) technology.
- The backbone of the technology lies in economical front-end hardware and data collection system.
- This is seconded by maturing of GNSS-SDR (Global Navigation Satellite System – Software Defined Radio) processors, receivers and software framework.
- The main challenge today lies in the establishment of standards to convey GNSS-SDR metadata, as existing metadata standards are not well suited for needs of GNSS-SDR and PNT(Position, Navigation and Timing) Community.
- ION-SDR Metadata standard aims for interoperability between GNSS-SDR data collection systems and processors.
- The main problem with recent proposed models is that they do not promote interoperability and data/resource sharing and re-use.
- Recently designed popular system model can be described as follows:
    - There are collection system blocks which could have single antenna, multiple antennas or sensors as the receiving units, used for collecting data.
    - The collected data is then sent to two blocks:
        - Formatting block, where data files are created as SDR files.
        - Another replica of data sets is sent to the meta-data formatter.
    - Then, the outputs of (i) and (ii) are set as inputs for GNSS-SDR Processor blocks.
    - This can be performed in many ways viz-a-viz :
        - Single/Multiple input(s) from a single formatting block to single/multiple GNSS- SDR Processor(s).
        - Single/Multiple input(s) from multiple formatting blocks to single/multiple GNSS- SDR Processor(s).
- This Ad-hoc Metadata exchange is prone to human error.
- Another area of our concern is that some front-end/DCS and SDR processors are bound to each other.
- To resolve the issues and for providing better interoperability, Metadata Standardization Technique is proposed. (Refer: Figure 1)

BENEFITS :

- The new technique would eliminate previous flaws and would provide an unambiguous transfer of all essential SDR metadata.
- The proposed solution will promote interoperability and data portability, resource sharing and re-use.
- Also, standardization encourages vendors to support major formats which would embolden spurs community to develop an open-source software handlers and plug-ins.(Refer: Figure 2)

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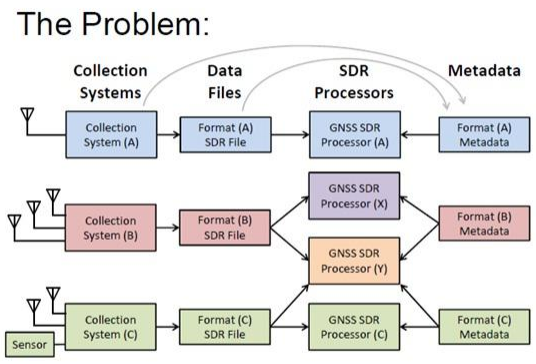

Figure 1

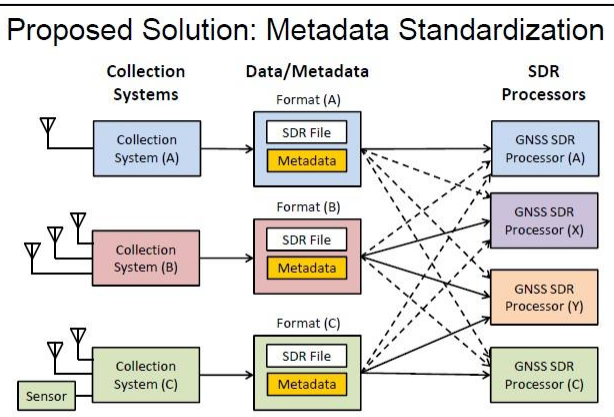

Figure 2

PROPOSED SOLUTION – I

(IMPLEMENTED) - *Auto_rx_conf.cc* :

In a nut-shell, this program performs the following tasks:

1. locates all the satellites that could be tuned in by the receiver.
2. sets up the logging system, creates a ControlThread object, makes it run, and releases memory back when the main thread has ended.
3. gathers information that is used for auto-configuration of receiver.
4. finds the bandwidth and center frequency of the signal.
5. calculates sample rate and sample resolution.
6. separates out different metadata formats into .xml and .bds files.

METADATA SPECIFICS:

- Different kinds of Collection System(s) receive data streams from the receiver(s) after receiver tunes to desired frequency.
- We find the total number of RF channels, bandwidth, center frequency, sample rate, and sample resolution for overall frequency spectrum received.
- The various forms for data/metadata formats are separated out and are written into .xml files.
- This segregation is performed as follows:
    - For all the RF channels available, calculate bandwidth and center frequency.
    - Determine the sample rate and sample resolution.
    - In each RF channel, separate out the data/metadata formats.
    - Then write the specific data/metadata formats into .xml and .bds files individually.
- SDR Processors can then process the separated files.

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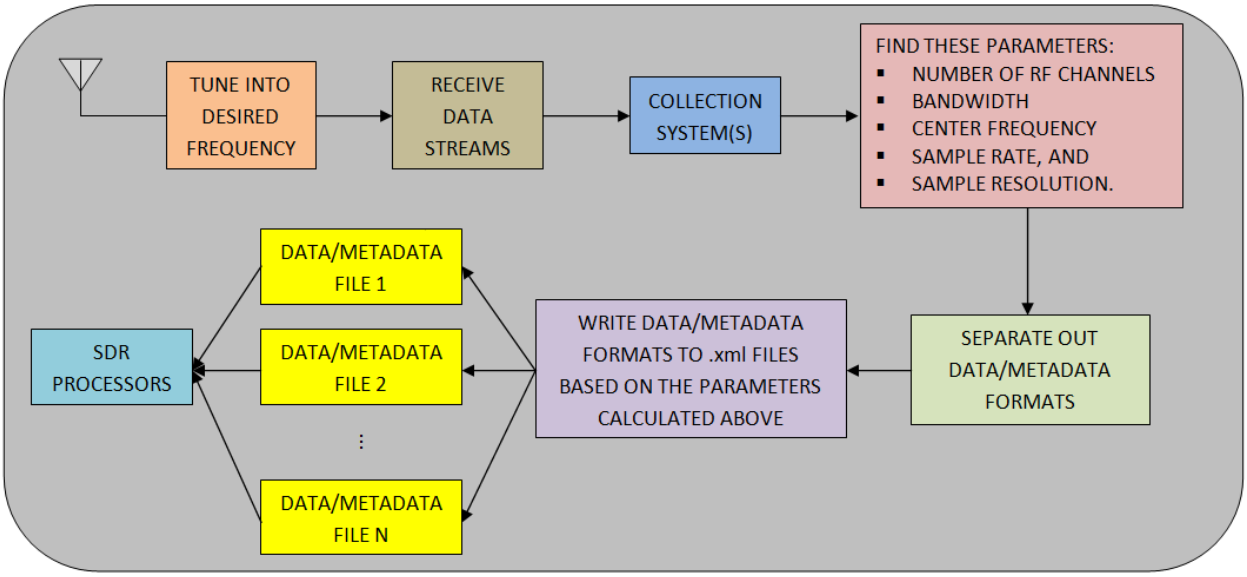
BASIC FLOW CHART:



PROPOSED SOLUTION – II (NOT IMPLEMENTED)

BASIC IDEA

1. Make a data set of all the possible data/metadata formats obtained.
2. We can use machine learning algorithms implementing unsupervised learning like ANN, Cluster Analysis, DNN etc to do so.
3. Keep rest of the process same as in Proposed Solution - I, but upto the step where we separate out data/metadata format files.
4. Let total number of independent data/metadata format files be '*M*' and total number of RF channels be '*N*', then we can assign some "header" bits to data/metadata format files.
5. The allocation of bits can be performed using the following:

$$Total\ number\ of\ bits\ needed: B = \left\lceil \frac{M}{2^N} \right\rceil.$$

6. Then, random assignment of bits for each data/metadata format file can be performed in: $\binom{M}{B}$ ways.
7. At the SDR processor, it will then be easy to segregate the files into proper order by taking help from header bits assigned.
8. By this technique, we can also achieve metadata standardization.
