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A Differential Reference Station Algorithm For Modular Decentralized GPS/GNSS Master Station Architecture

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Why master station ?

- An important benefit of GNSS is that it can provide absolute time and position information anytime anywhere
- To help users on wide area to generate accurate estimates on absolute time, position, and atmospheric delays, an efficient master station algorithm is required

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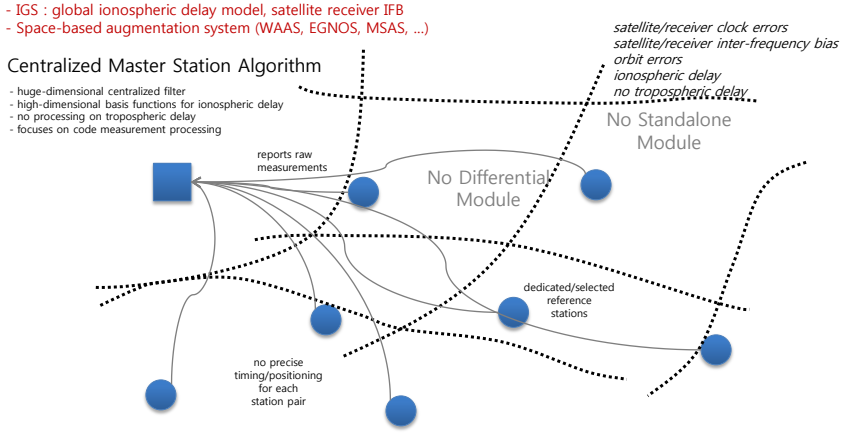
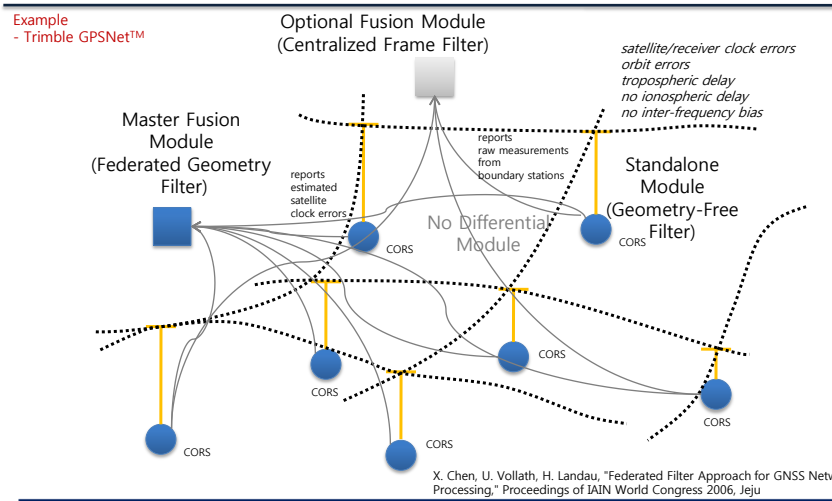
Conventional Centralized Approach

Examples
- GPS master station : satellite/receiver IFB
- IGS : global ionospheric delay model, satellite receiver IFB
- Space-based augmentation system (WAAS, EGNOS, MSAS, ...)



Conventional Decentralized Approach

Example
- Trimble GPSNet™

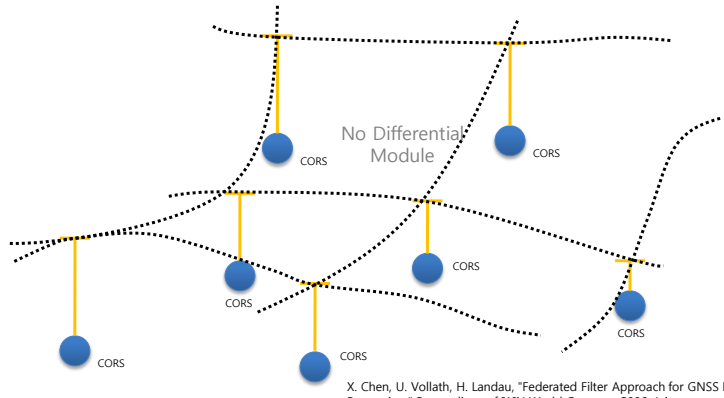


X. Chen, U. Vollath, H. Landau, "Federated Filter Approach for GNSS Network Processing," Proceedings of IAIN World Congress 2006, Jeju

Conventional Approach for Precise Inter-Station Processing

Example
- VRS, FKP, MAC

DD integer ambiguity resolution
no differential timing
no differential IFB



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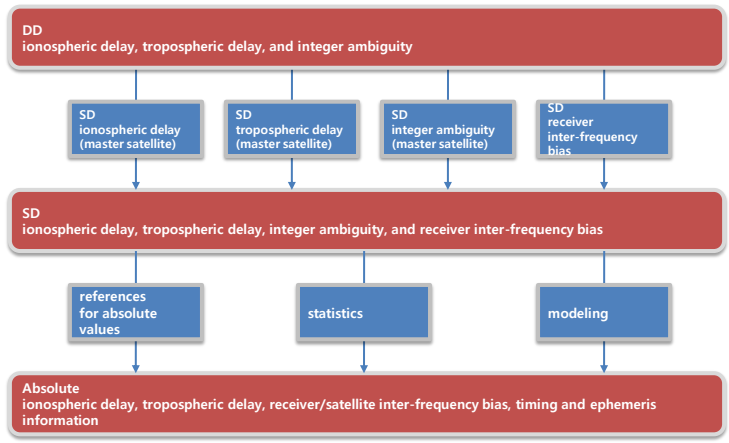
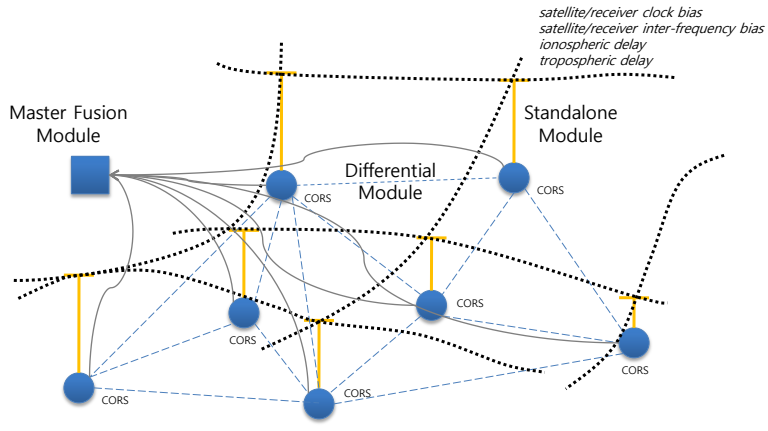
Hierarchy of Variables For Proposed Architecture



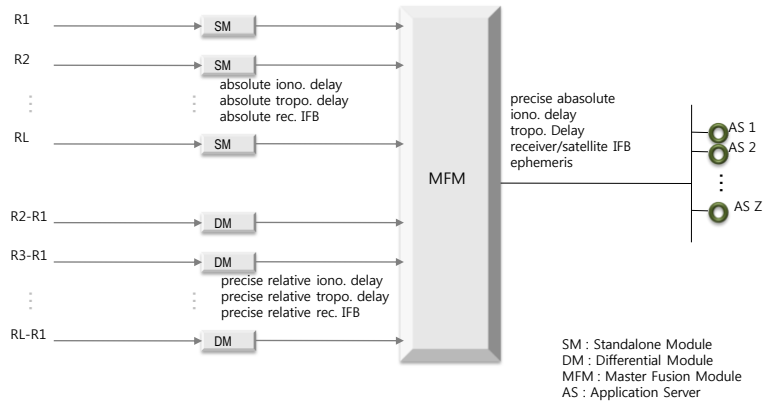
Modular Decentralized Master Station (MDMS) Architecture



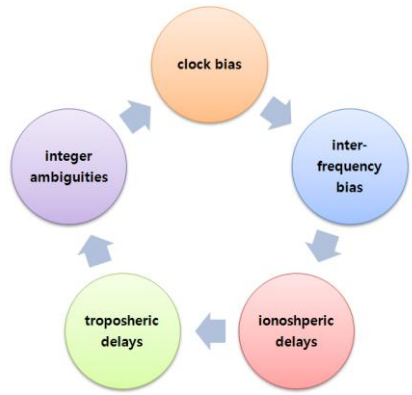
Description of Important Modules

- A **DM** (differential module) generates **accurate** estimates on **differential** receiver inter-frequency bias (IFB), ionospheric delay, and tropospheric delay
- An **SM** (standalone module) generates **coarse** estimates on **absolute** IFB, ionospheric delay, tropospheric delay, and residual biases for each satellite
- An **MFM** (master fusion module) combines information from DMs and SMs to generate **accurate** estimates on **absolute** values

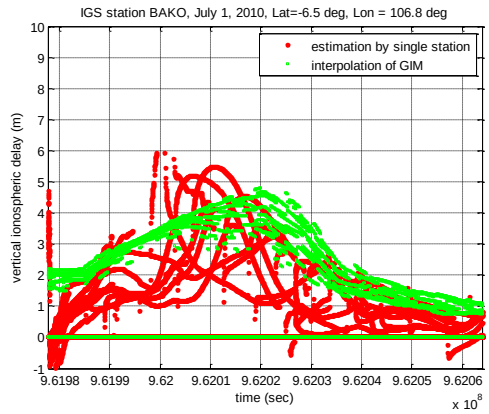
Data Flow



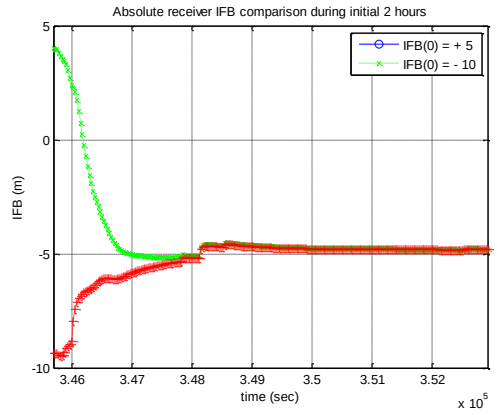
Internal relationship between state variables for accuracy



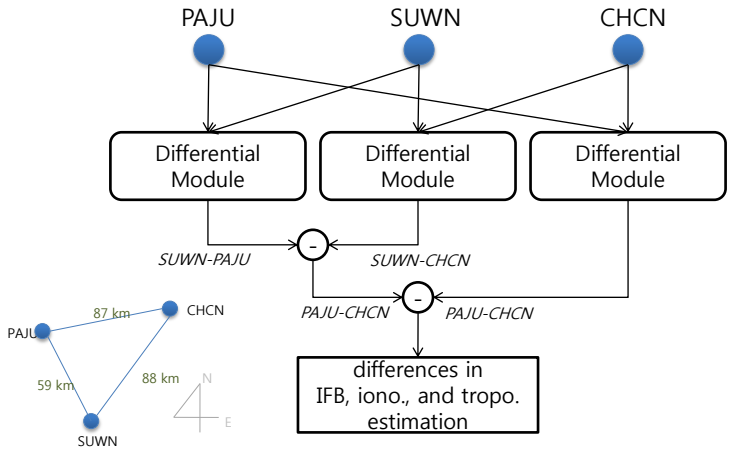
Processing Example of Standalone Module (SM) : Absolute Ionospheric Delay



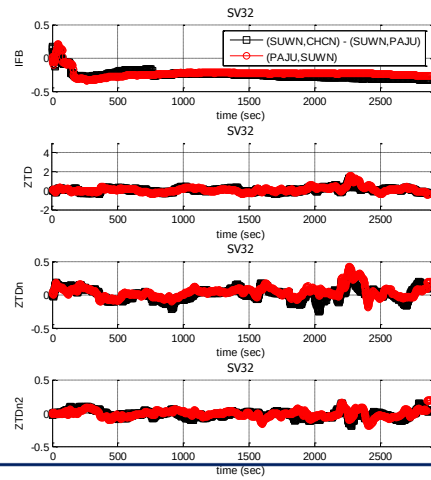
Processing Example of Standalone Module (SM) : Absolute Inter-Frequency Bias (IFB)



Processing Example of Differential Module (DM)



Differential IFB and Tropospheric Delay Parameters

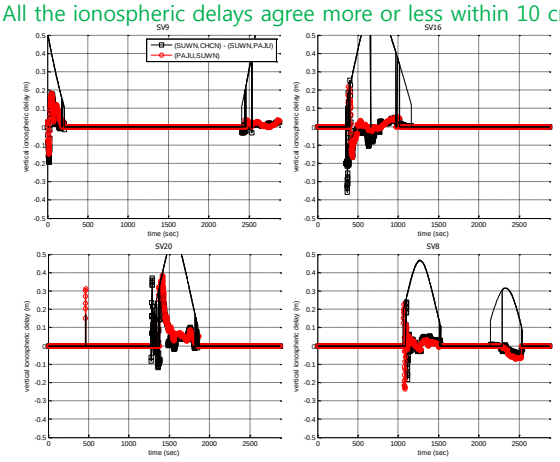


The maximum difference of differential IFB corresponds to 8 cm.

The maximum difference of differential zenith tropospheric delay corresponds to 30 cm.

Differential Ionospheric Delays

All the ionospheric delays agree more or less within 10 cm.



Conclusions

- An efficient modular decentralized master station (MDMS) architecture is proposed
- The proposed MDMS consists of differential modules (DMs), standalone modules (SMs), and a master fusion module (MFM)
- Previous study verified that a prototype SM can estimate absolute inter-frequency bias
- In this study, an efficient DM algorithm is designed and verified by an experiment
- Additional work is planned for a prototype MFM