GNSS Real-Time Developments at GFZ

PY03 – IGS Real-Time Service on the way to FOC

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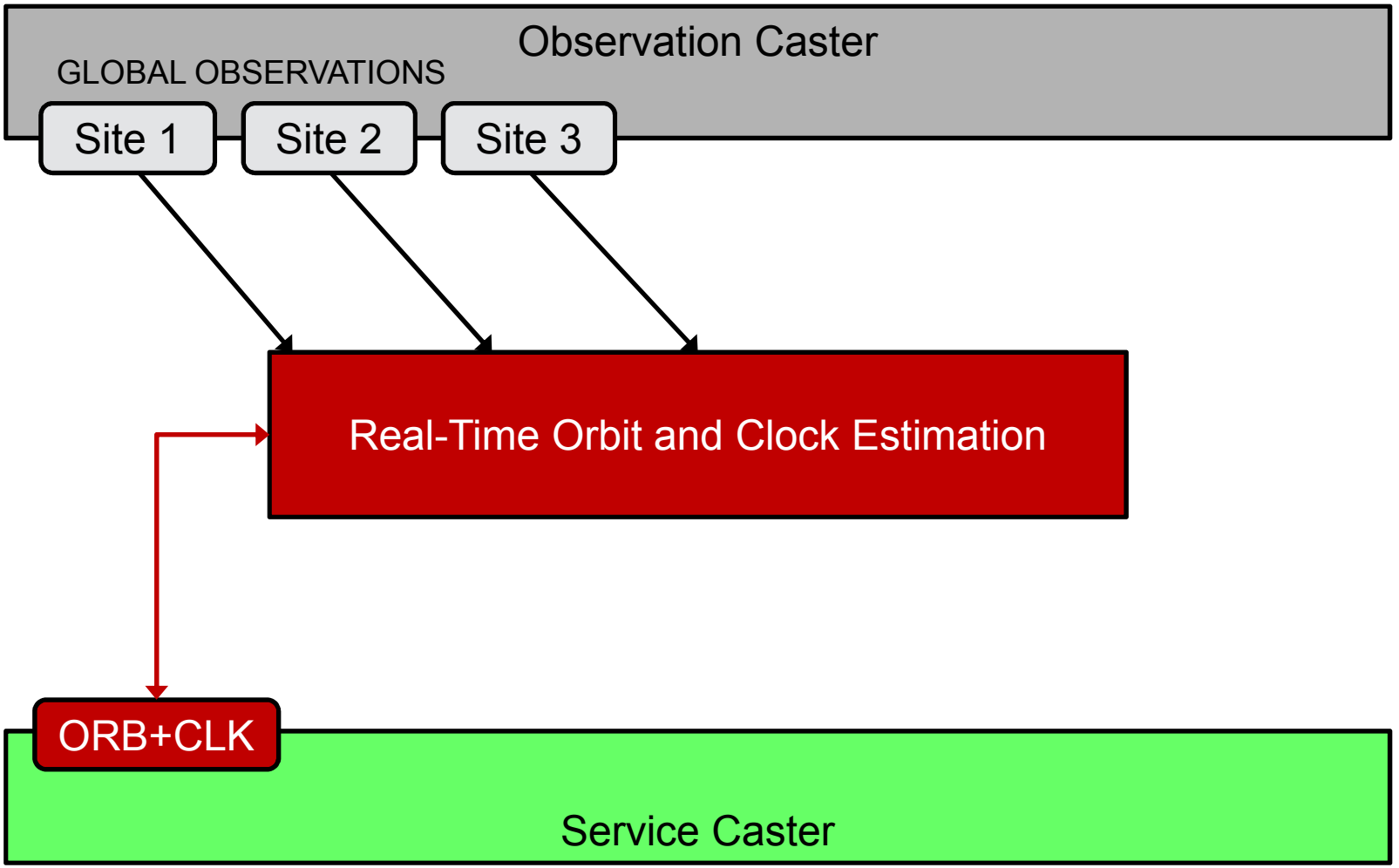
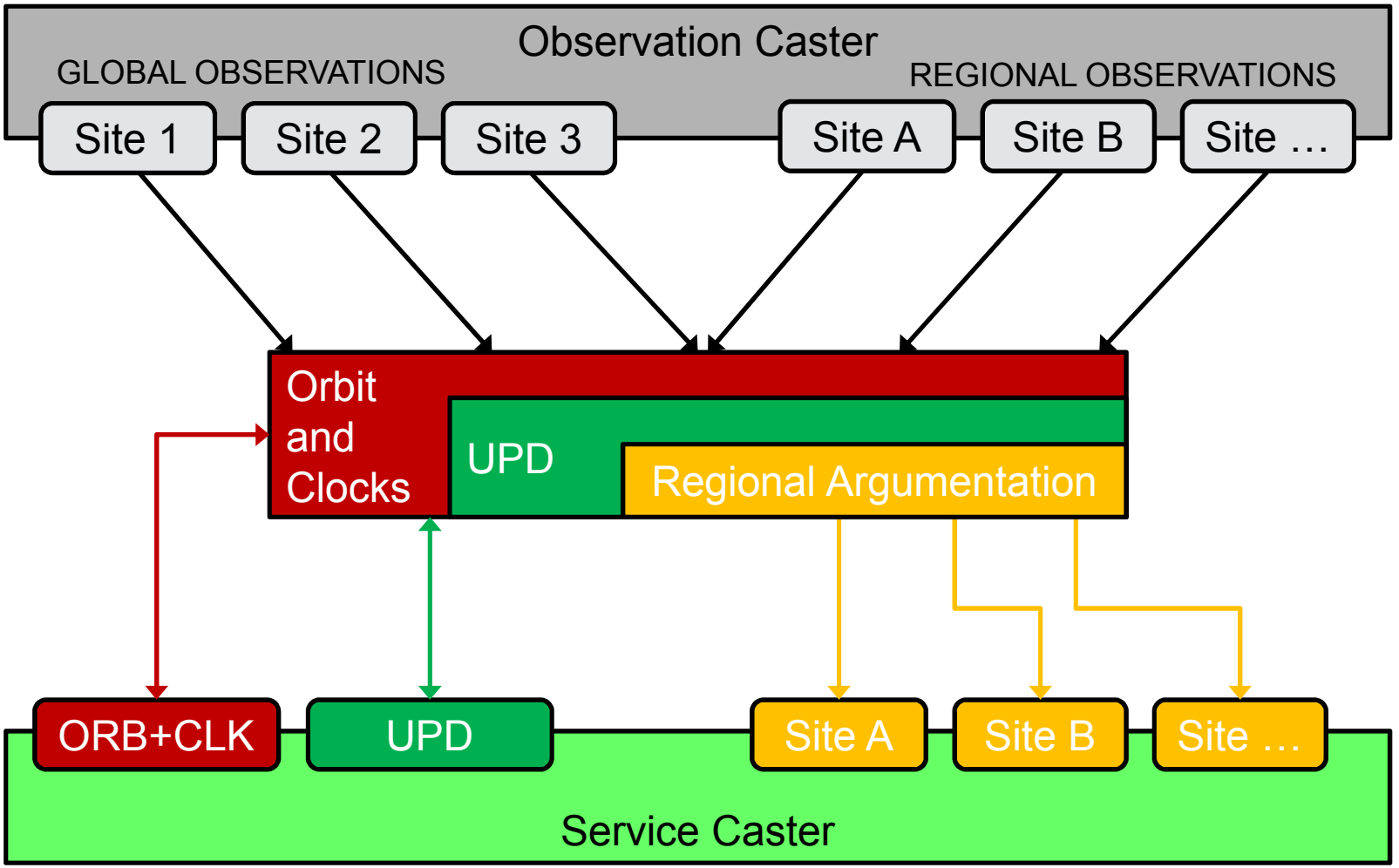
Outline

1. Real-Time Positioning Service at GFZ
2. Future requirements and challenges
3. Integration of Carrier Range Concept

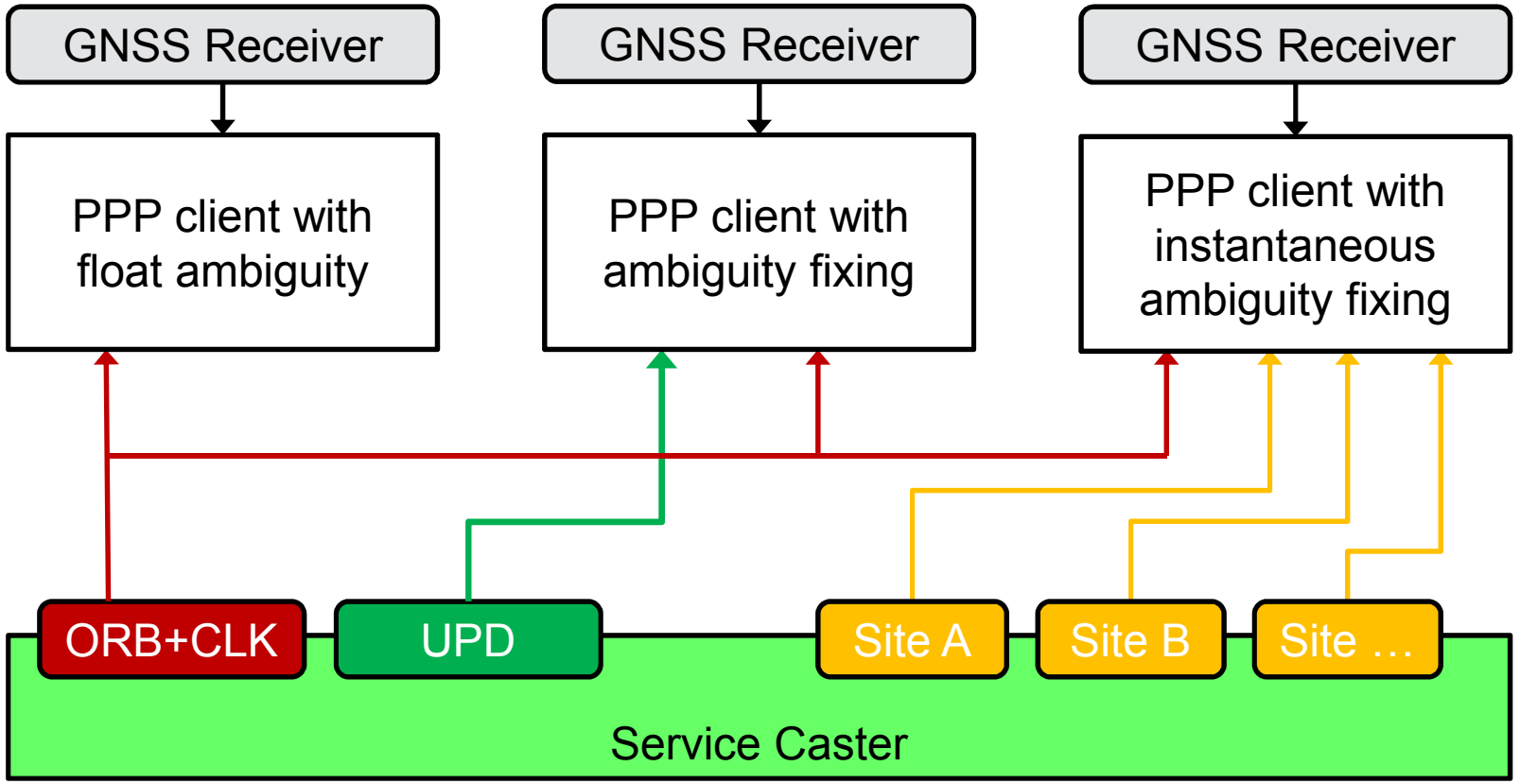
GFZ Real-Time Positioning Service



GFZ Real-Time Positioning Service



GFZ Real-Time Positioning Service



Future requirements and challenges

Do we need a multi-GNSS multi frequency (2+) global PPP service for the IGS?

- Use of different coordinate references by individual system provider
- Use of different time scales
- Combination must be performed on user side
- Limitations in terms of accuracy and consistency and possibly also for specific applications
- Common treatment of different GNSS and frequencies in an integrated orbit and clock estimation

Future requirements and challenges

More GNSS Constellations

- Increasing number of satellites
  (GPS: 32, GLONASS: 24, Galileo: 4, Beidou: 14)
- Additional new signals

Increasing number of network stations

- Consistency among global and site-specific PPP results

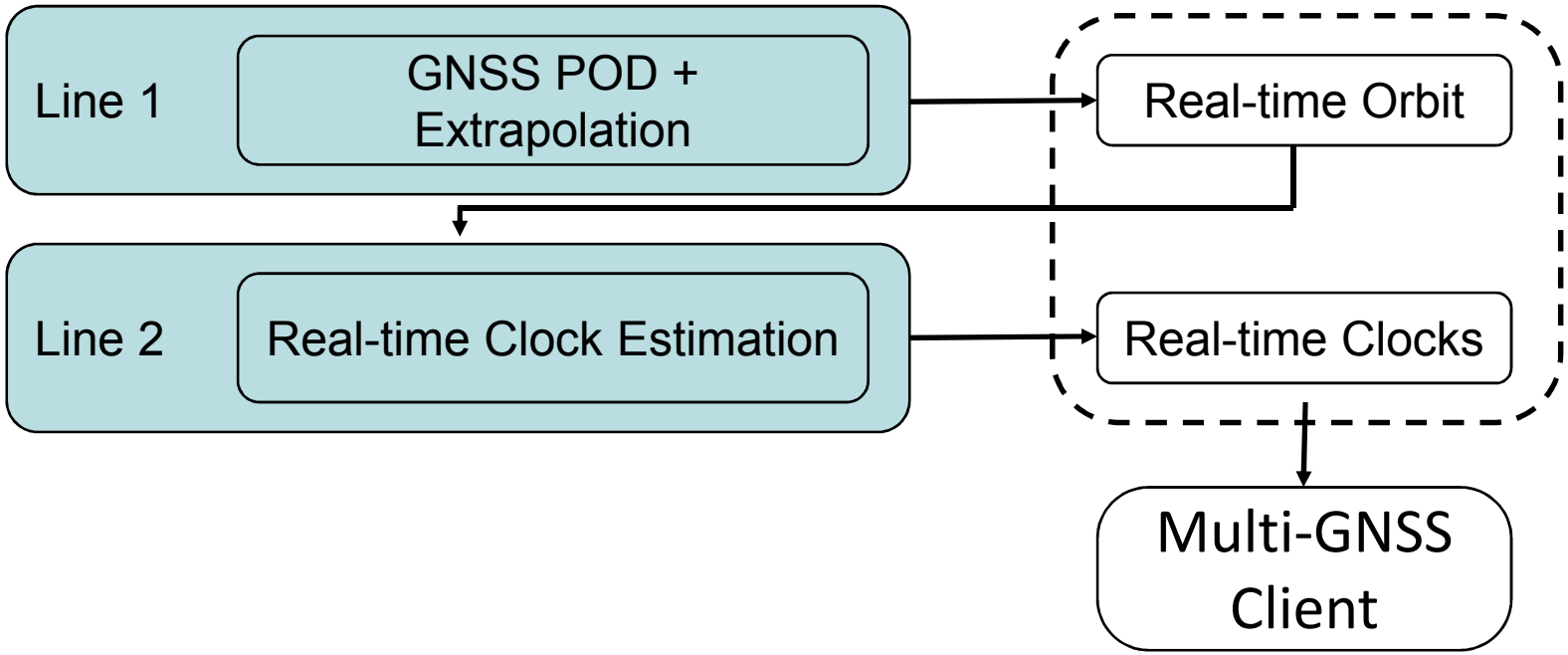
Challenges

- Inter system biases
- Additional frequencies
- Computational burden (number of simultaneous parameters)
- Efficiency for high update rates

Multi-GNSS Real-Time PPP

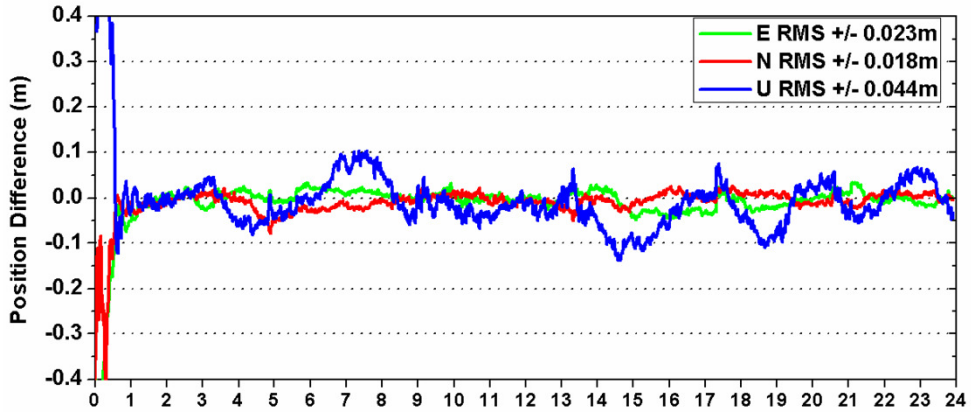
Simulated real-time PPP environment

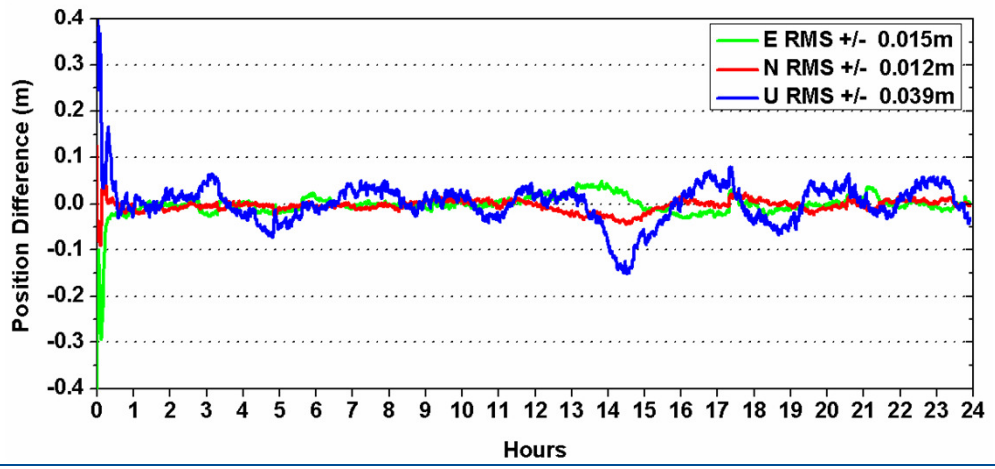
- Validation of standard PPP approach
- Strategy: GPS-only, GPS+GLONASS+Galileo+Beidou

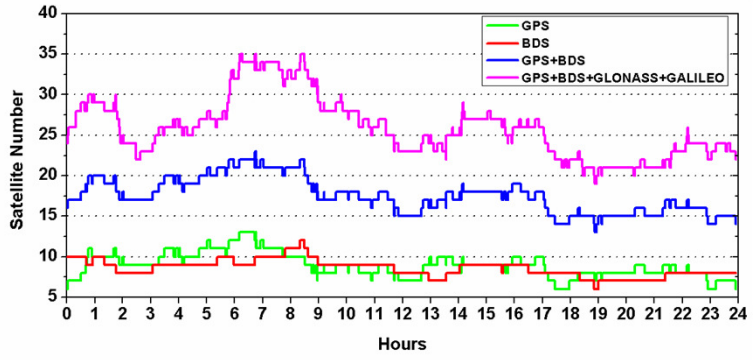


Multi-GNSS Real-Time PPP

GMSD station (Japan)







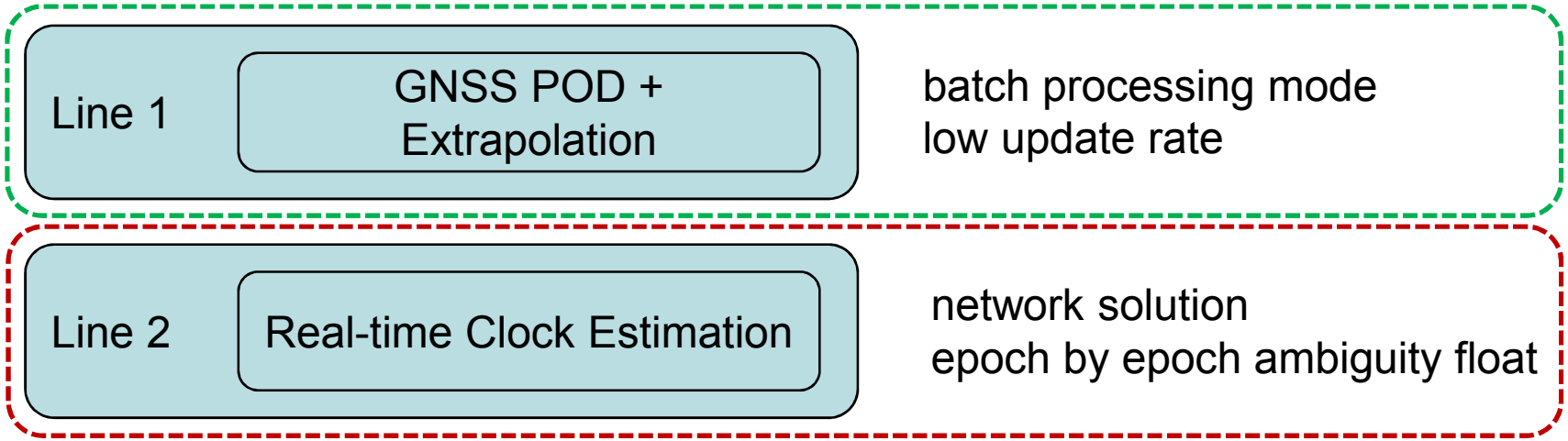
GPS-only
Convergence: ~30min

GPS+GLONASS+GAL+BDS
Convergence: ~10min

Multi-GNSS Real-Time PPP

Parameters	Number	
Satellite clocks	~ 74	
Receiver clocks	~ 120	
ZTD	~ 120 (per 120 minute)	
Horizontal gradient	~ 240 (per 1440 minute)	
Ambiguity	~ 1200	
Inter-system Biases	~ 110 (1 par per system per station, GPS as reference)	fixed
Inter-frequency Biases	~ 2210 (1 par per GLONASS satellite and station, GPS as reference)	
sum	~ 4074	Process time: ~ 15 sec
sum	~ 1754	~ 2 sec

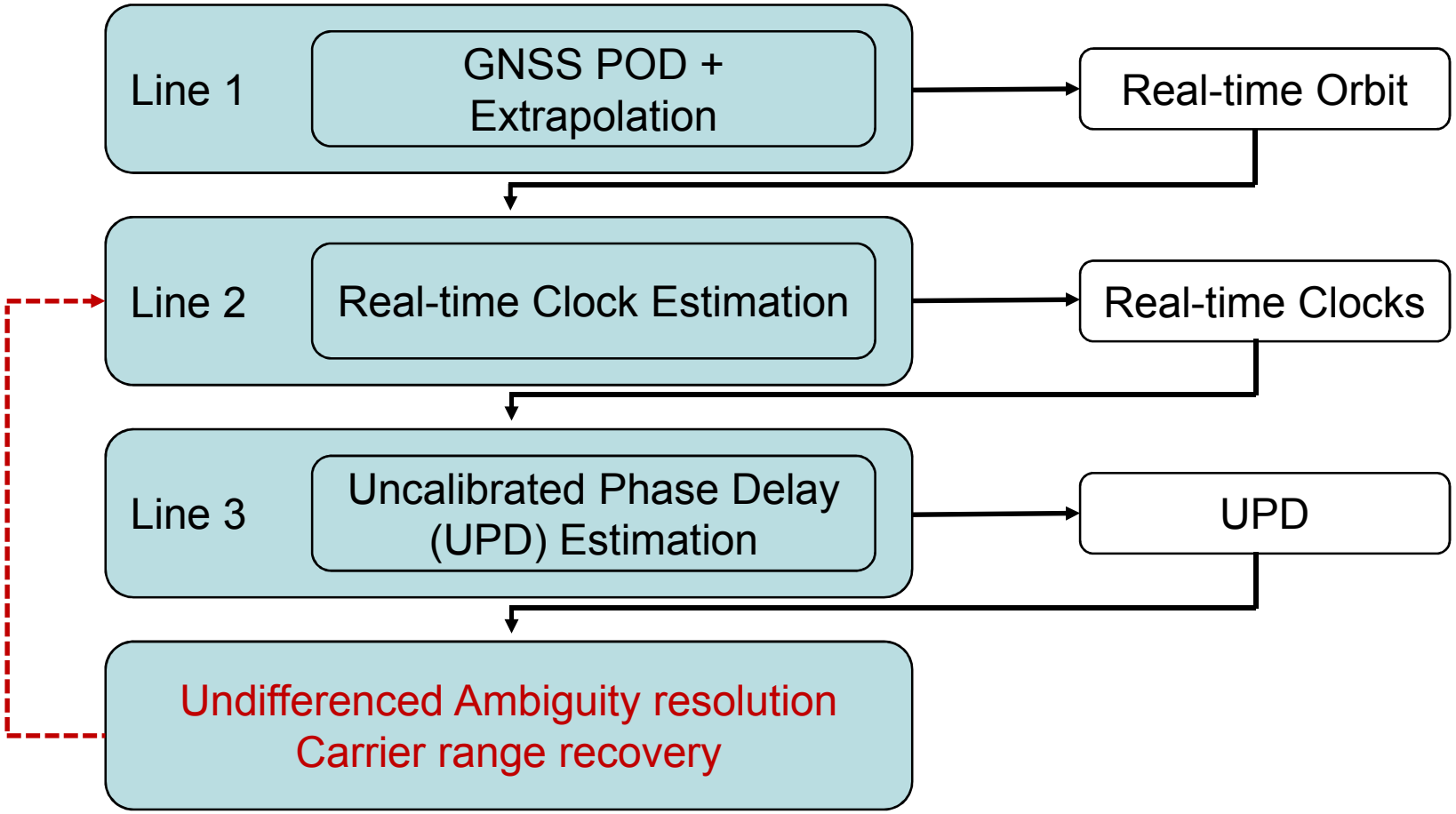
Integration of Carrier Range Concept



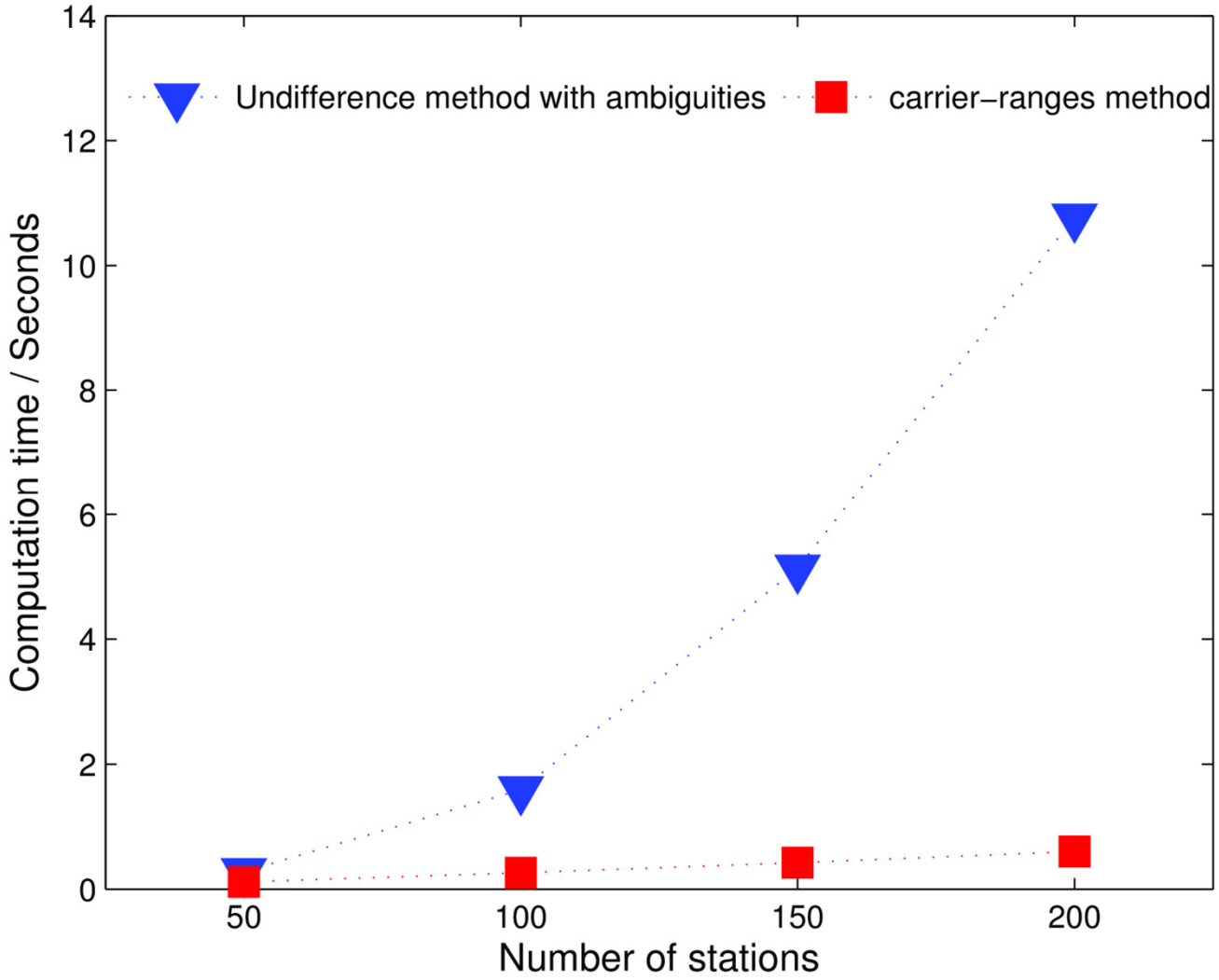
Motivation for Carrier Ranges (Blewitt et al.)

- Exponential increase of number of ambiguities with additional stations and satellites
- Undifferenced carrier phase ambiguity resolution
- Recover and re-introduce carrier ranges

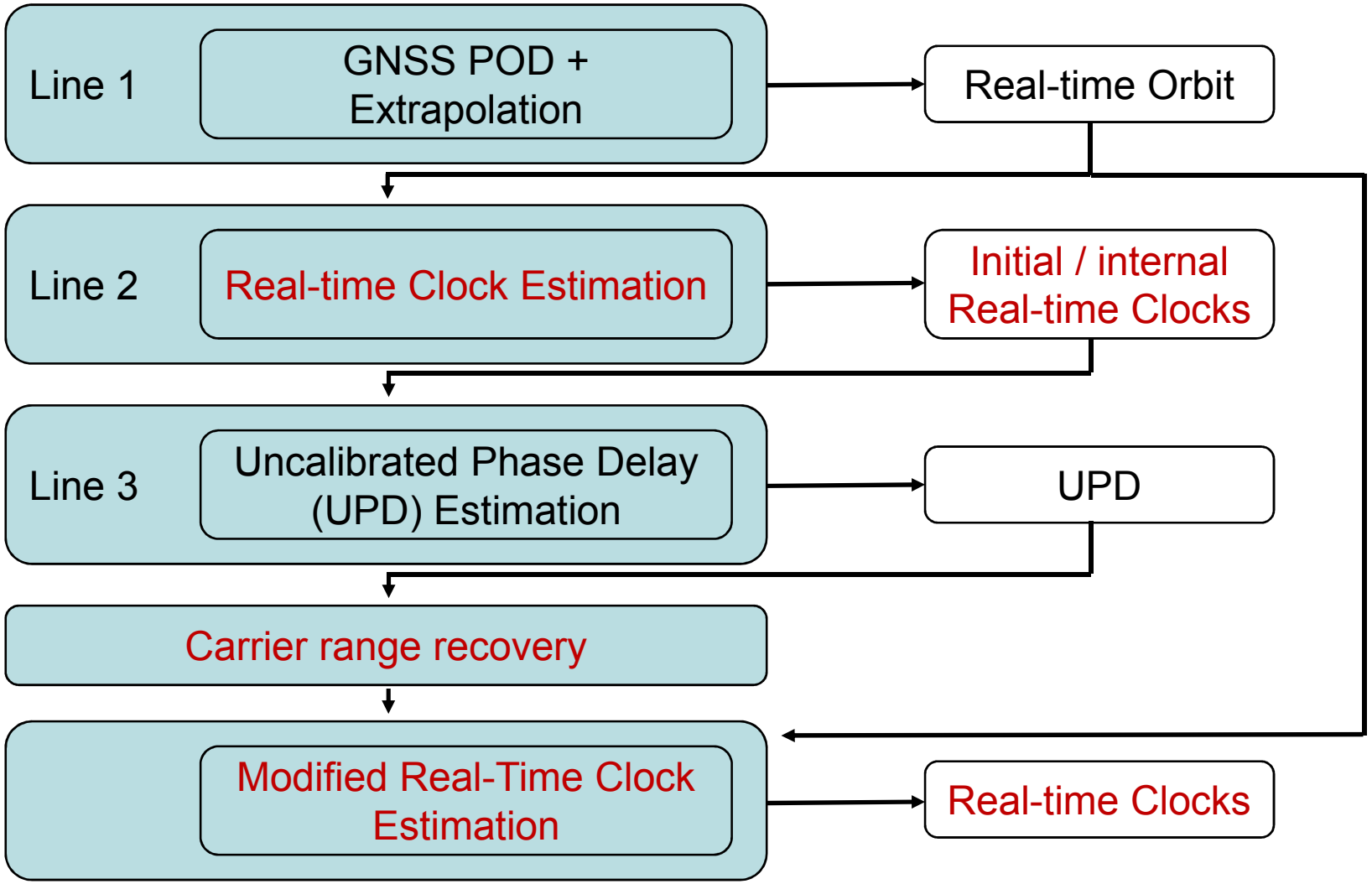
Integration of Carrier Range Concept



Integration of Carrier Range Concept



Integration of Carrier Range Concept



Integration of Carrier Range Concept

Advantage of using Carrier Ranges

- Highly efficient due to station-wise computation
- Approach 1: multi-GNSS initial clock solution and multi-GNSS clock solution based on carrier ranges
- Approach 2: system by system initial clock solution and multi-GNSS clock solution based on carrier ranges
- Initial clock and UPD solution based on selected global station network
- Additional stations in the step of carrier range recovery

Conclusions

- Multi-GNSS real-time PPP service provides shorter convergence time and better accuracy at client side
- Proposed processing scheme including carrier ranges shows to be a feasible concept
- Significant reduction of computational burden using carrier ranges
- Integrated orbit and clock estimation for multi-system and multi-frequency GNSS applications

Thanks for your attention