RECENT DEVELOPMENTS IN PRECISE GNSS-BASED POSITIONING AND NEAR-TERM OPPORTUNITIES

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2018 Joint Canadian Hydrographic Conference and National Surveyors' Conference



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Canadian Ocean Mapping

OVERVIEW

- GNSS "evolution"
- GNSS measurement processing developments
 - What's (relatively) new with Precision Point Positioning (PPP)
- Development of more capable, low-cost hardware
 - A potential paradigm shift for precise positioning
- Non-GNSS navigation sensors
 - Satelles STL, 5G, MEMS IMU, CSAC
- Near-term opportunities in land surveying and hydrography
 - Smaller, cheaper, autonomous



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EXPECTED GNSS USES FOR GLOBAL REVENUE BY MARKET SEGMENT: 2013-2023



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GLOBAL AND REGIONAL NAVIGATION SATELLITE SYSTEM "EVOLUTION"



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NEARING 100+ GNSS/RNSS SATELLITES IN ORBIT



[Hothem, 2012]



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IMPACT OF MULTI-GNSS ON TERRESTRIAL USERS: NUMBER OF VISIBLE SATELLITES





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PPP: WHERE ARE WE NOW, AND WHERE ARE WE GOING?





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USEFULNESS OF PPP

- PPP used in <u>remote areas</u> or <u>regions of low economic density</u>
- Limiting or preventing the use of relative GNSS, RTK, NRTK for precise positioning / navigation
- But allows for continuous satellite tracking
- In post-processing or real-time
- Free on-line and commercial services



PPP IN PRECISION AGRICULTURE







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MULTI-GNSS HORIZONTAL PPP PERFORMANCE

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TRIPLE-FREQUENCY, MULTI-GNSS HORIZONTAL PPP PERFORMANCE





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TRIPLE-FREQUENCY GNSS PPP WITH GLOBAL IONOSPHERE MAP PERFORMANCE



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NEW LOW-COST, MULTI-FREQUENCY GNSS RECEIVERS: EXAMPLES





Broadcom GPS L1/L5, GLONASS L1, Galileo E1/E5a, BDS B1, QZSS L1/L5 chip

Unicorecomm GPS L1/L2/L5, GLONASS L1/L2, Galileo E1/E5a/E5b, BDS B1/B2/B3 chip





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- Targeting mobile and automotive commercial markets
- RTK-capable performance
- More coming

SATELLETES

- Satelletes Inc.
- Objective: to augment and enhance existing solutions, including GNSS
- Timing and location solutions over the Iridium constellation of 66 low-Earth orbit satellites
- Major Satellite Time and Location (STL) system potential benefits from early testing:
 - Anti-jamming
 - Anti-Spoofing
 - Outdoor / indoor operation
 - Tens of metres accuracy



5G POSITIONING creative passionate NR Standalone LTE GNSS rational Stand alone systems (ÚWB, RedFIR) D-GNSS confident GNSS LTE RTK 1 km 1 cm 10 cm 1 m 10 m 50 m 100 m [https://www.iis.fraunhofer.de ingenious LASSONDE /en/ff/lv/lok/tech/5g.html] SITÉ UNI CHOOL OF ENGINEERING UNIVE RSI

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MEMS IMU ADVANCEMENT



CHIP-SCALE ATOMIC CLOCK (CSAC)

- e.g., Microsemi SA.45s
 - <17 cm³
 - 35 grams



- <1x10⁻¹¹ @1000 sec short-term stability (Allan deviation)
- <1K USD
- Can be combined with GNSS (w or w/o PPP) and MEMS IMU
- Potential in: Anti-GNSS jamming; anti-spoofing; urban canyons; urban environments; indoor positioning



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SUMMARY

- New data processing developments
- Lots of exciting new hardware developments
- Big commercial markets, e.g., automotive, mobile
- New applications that have not yet been considered
- Some of these improvements will have direct and indirect affects on the land surveying and hydrographic communities:
 - Small, cheaper, autonomous systems
 - Consumerization of high-precision positioning, navigation and orientation

