International Committee on Global Navigation Satellite Systems

International Federation of Surveyors (FIG)

GNSS Precise Point Positioning (PPP)

From Users' Perspective

UNOOSA ICG
Xi'an, China, November 2018

Suelynn Choy – Chair, Working Group 5.4 on GNSS
Mikael Lilje – Vice President, FIG
Matt Higgins – Honorary Member, FIG

Established in Paris 1878;

Federation of national associations;

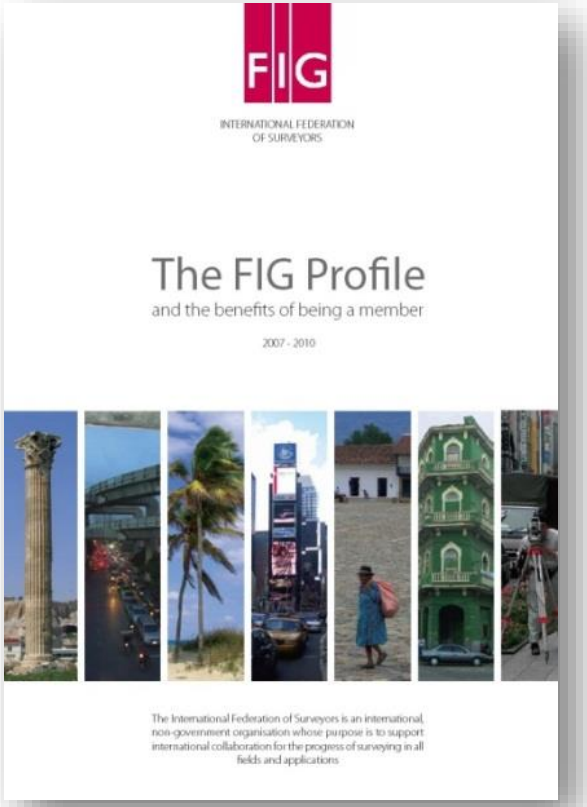
Represents all surveying disciplines;

UN-recognised non-government organisation (NGO);

Its aim is to ensure that the disciplines of surveying and all who practise them meet the needs of the markets and communities that they serve;

It provides an international forum for discussion and development aiming to promote professional practice and standards

Liaise with like minded organisations



https://www.fig.net/

IAG

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UN-GGIM
UNITED NATIONS INITIATIVE ON GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

International Federation of Surveyors
Fédération Internationale des Géomètres
International Vereinigung der Vermessungsingenieure

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CSSMG (China)
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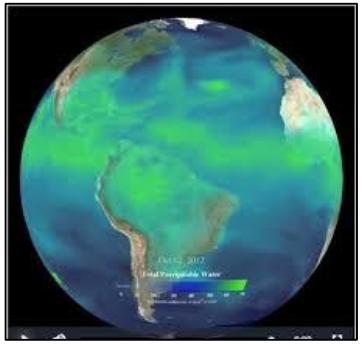
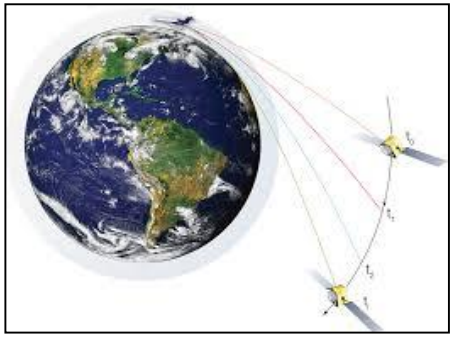
GNSS precise positioning enables a diverse array of applications









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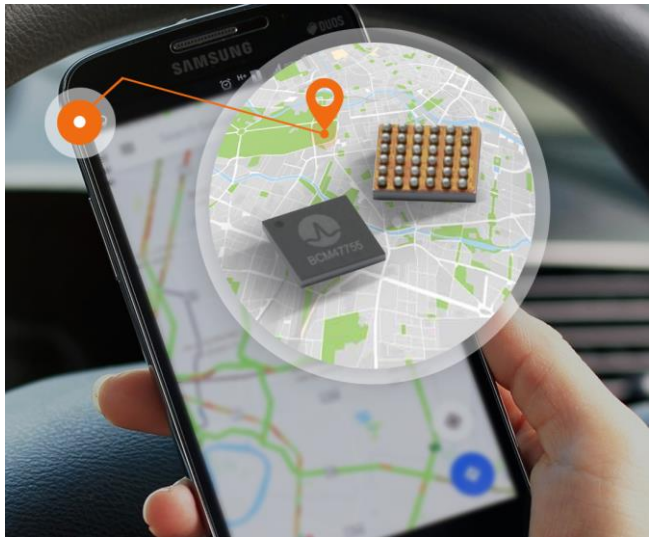
Mass-market users and innovative applications



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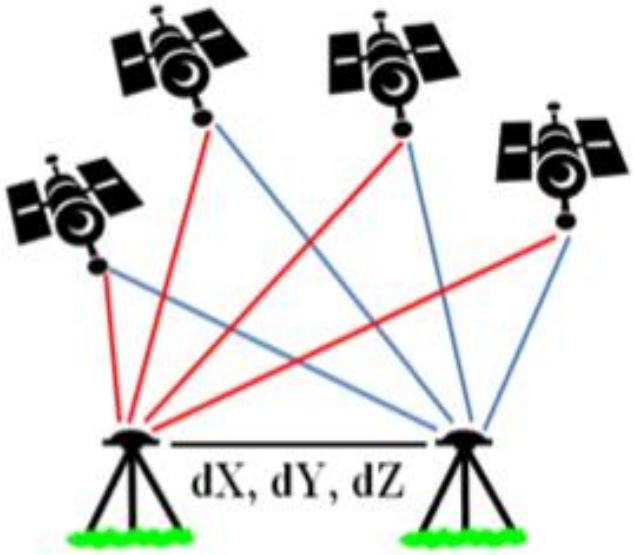
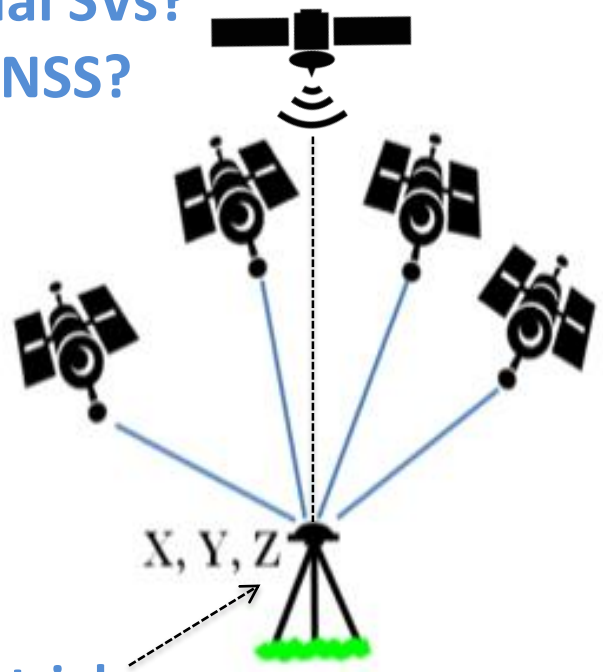
Precise Point Positioning (PPP)



Differential

Commercial SVs?
GNSS/RNSS?



Terrestrial

PPP

PPP uses **state space representation (SSR) correction** products such as **precise satellite orbits**, **clocks** and **signal biases** from either *(1) commercial or/and public providers* that are delivered to the user via *(2) satellite and/or terrestrial comms*.

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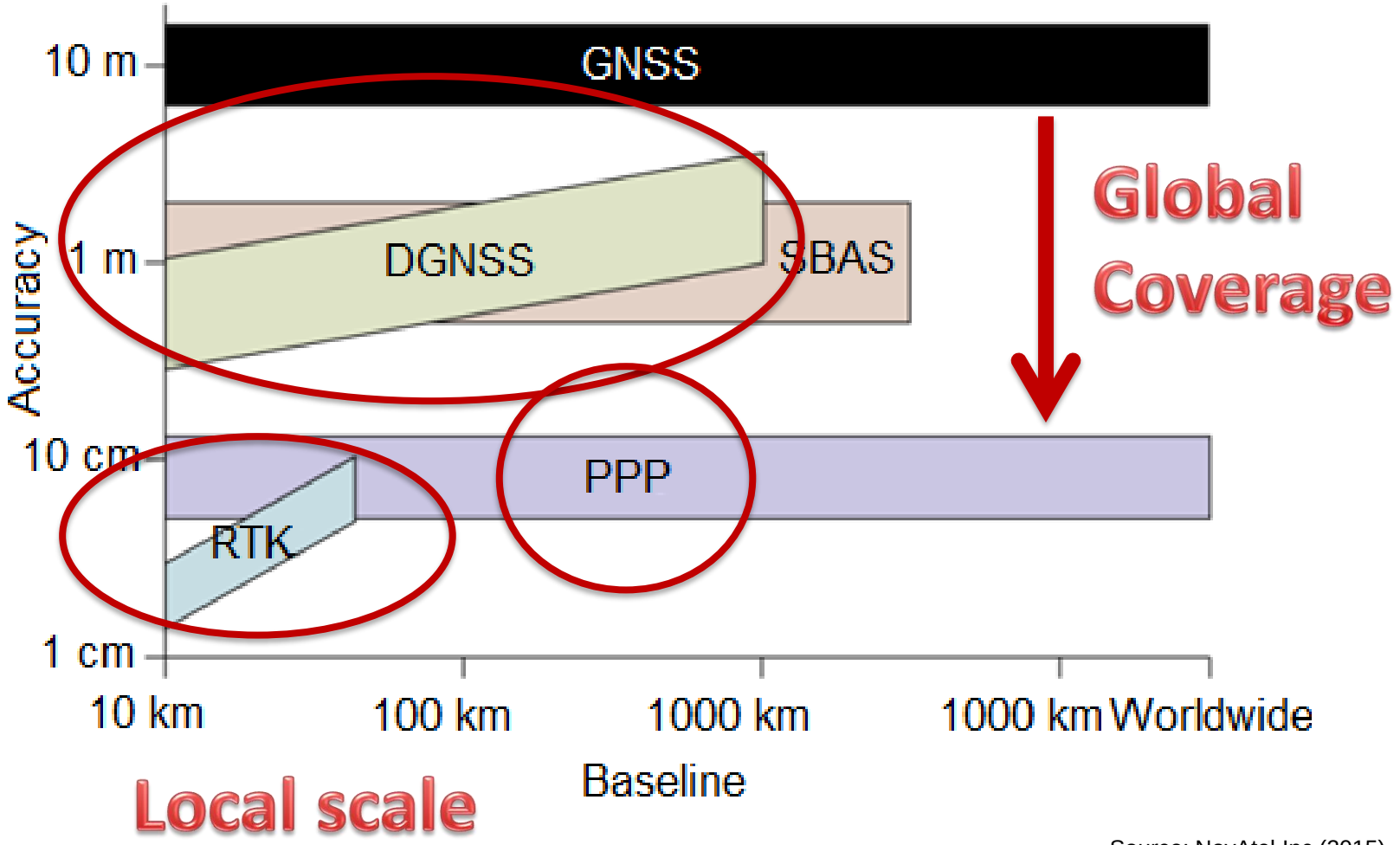
Pushing the boundary of precise positioning



Source: NovAtel Inc (2015)

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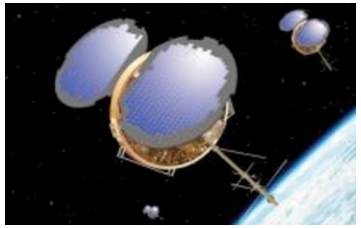
Use and Applications

- Commercial PPP Services, e.g.,
  - Trimble CentrePoint™ RTX™
  - NavCom Global StarFire™ Service
  - Fugro's Precise (Point) Positioning Service
  - Veripos Ultra (Ultra²) and APEX (APEX²) Service
  - TerraStar Correction Services







PPP is **feasible** for positioning and navigation in **remote areas** or regions of **low GNSS reference stations**

PPP Service:

Compatibly and Interoperability

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PPP Augmentation Signals by GNSS and RNSS

System	SV Orbit	Augmentation Signal for PPP	Frequency (MHz)	Bandwidth (bps)
Galileo/	MEO	E6	1278.75	500
EGNOS	GEO	E5b	1207.14	250
GLONASS/	MEO	L1 or L3 ?	?	?
SDCM	GEO	L1 or L5 ?	?	
BeiDou-3	GEO	B2b	1207.14	1000
QZSS	IGSO and GEO	L6D, L6E	1278.75	2000
Australia	GEO	L1	1575.42	250
		L5	1176.45	250

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GNSS and RNSS PPP Service Characteristics

System	Coverage	Format	Supported GNSS/RNSS	Supported Service
Galileo/ EGNOS	Global	Open ?	?	?
GLONASS/ SDCM	Global	Commercial ?	?	?
BeiDou-3	Regional	Open ?	?	?
QZSS	Regional	Open	GPS, QZSS, GLO & GAL	PPP-AR SSR-RTK (JAP)
Australia	Regional	Open	GPS & GAL	PPP-float

* PPP-float: Standard float ambiguity PPP
PPP-AR: Ambiguity resolved PPP
SSR-RTK: RTK based on state space representation method

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Which PPP Service ?

	PPP	PPP-AR	SSR-RTK*
Satellite orbits	✓	✓	✓
Satellite clocks	✓	✓	✓
Code biases	✗	✓	✓
Phase biases	✗	✓	✓
Ionospheric delay	✗	✗	✓
Tropospheric delay	✗	✗	✓

*Hybrid system of PPP and RTK, i.e. SSR-RTK/PPP-RTK/RTK-PPP

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Precise Point Positioning (PPP)

Precise Point Positioning (PPP) allows a single GNSS receiver user to determine position at the decimetre / centimetre error level in kinematic / static mode using precise satellite orbits and clocks.

Standard Positioning Service

Broadcast orbit and clock information

+

User satellite tracking information (code measurement)

=

m-level user position estimates

Precise Point Positioning

Precise orbit and clock information *

+

User satellite tracking information (code + carrier phase measurements) *

+

Additional error modelling *

=

dm- to cm-level user position estimates

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User Algorithm and Service Characteristics

System	Precise Orbits Reference Frame	Precise Clocks Reference	Definition of phase biases	Performance
Galileo/ EGNOS				
GLONASS/ SDCM				
BeiDou-3				
QZSS	ITRF			
Australia	ITRF 2014	Hydrogen-maser; C1P2 reference	-	

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Next Steps ?

- High precision GNSS in the future
  - Is it a commodity? Or high-tech?
- Ensure compatibility and interoperability to maximize benefit to all GNSS users
- Outcomes from WG-D meeting in Melbourne on 24 October 2018:
  - Briefing document / “PPP template”
  - Coordination with other WGs, e.g., Joint WG-D and WG-S discussion on Wednesday 7 November, 10:50-12:00
  - Possible joint meeting mid 2019