Dynamic Positioning Committee
Marine Technology Society

Sensors

DGNSS Position Quality Information for DP Applications

David Russell
Subsea 7/Veripos

October 9-10, 2007

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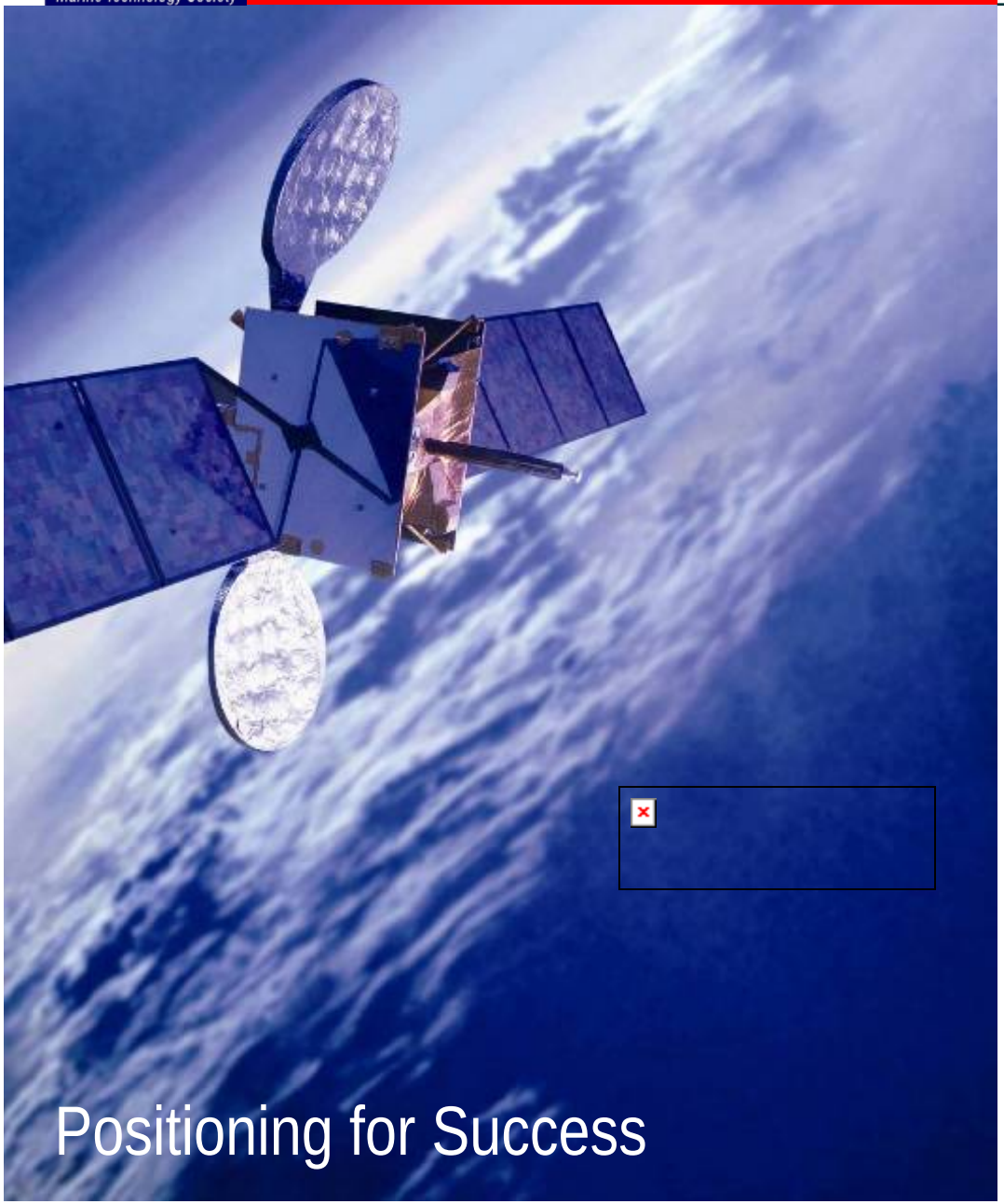
Marine Technology Society



DGNSS Position Quality Information for DP Applications

David Russell

MTS-DP Conference

9th-10th October 2007

veripos

Overview

- **Introduction**
- **Advances in Positioning Technologies**
- **Position Quality Standards**
  - NMEA
  - UKOOA
  - IMCA
- **Considerations for DP Applications**
- **Conclusions**
- **Recommendations**

Introduction

- **Positioning techniques can now delivery position solutions at the decimetre level**
  - Future enhancements will see new satellite constellations and modernization of the current systems
  - Will see developments with new position solutions
    - Different levels of accuracy
    - Different combinations of satellite signals
  - Differing solutions require to be weighted differently in the DP system
    - Therefore, not only is a position required but associated quality information to allow proper solution weighting

Importance of GNSS to DP

- **Positioning is critical to all DP Operations**

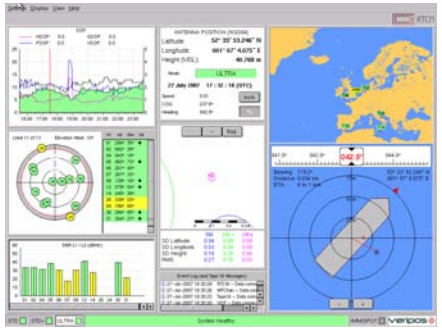
- **Requirements for DP Operations**

  - Both precision and accuracy are important for DP operations

  - DP position reference must provide a reliable & stable position solution

  - Validity and quality of instantaneous position solution has to be assessed immediately so action can be taken

  - Other reference systems such as acoustics, taut-wire – mean less dependence on DGNSS

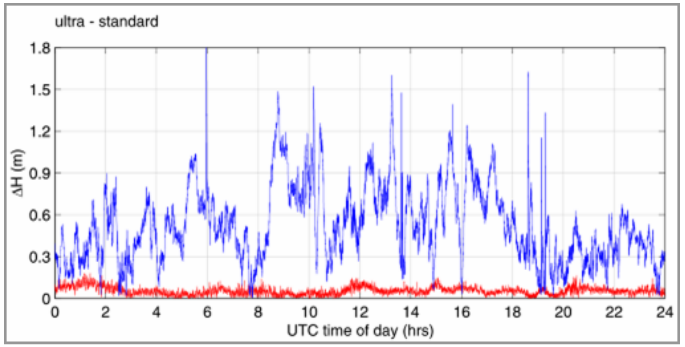


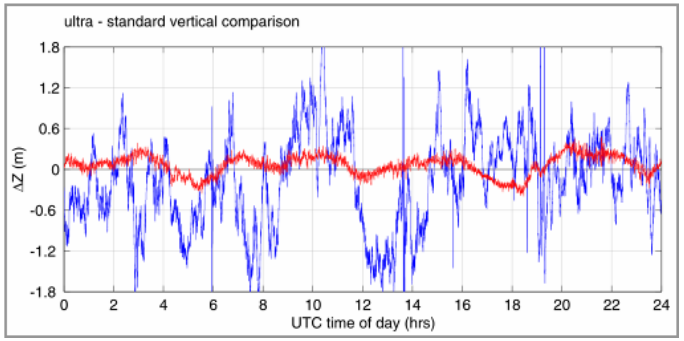
The Potential Consequences of a Loss of Position

Source:
Managing Dynamically Positioned (DP) Operations - *A Practical Approach - An Operator's Perspective*
Suman Muddusetti & Tracy Harris - **Shell International Exploration and Production Inc.**

Advances in Positioning Technologies

- **Positioning is essential technology for the oil and gas industry**
  - Satellite Navigation technology can now be considered a mature and accepted technology
- **Augmentation data from service providers allows a higher level of accuracy & precision over standalone GPS**
  - Services offered range in accuracy from the metre level to the decimetre level
  - Implications when position references of different accuracy levels are used in DP system
- **Satellite navigation will remain a key technology for offshore operations**





Position Quality Standards

- **Within the offshore industry a number of position quality recommendations and guidelines exist**
  - Provide quality information on the calculated position
  - Allow user to accept or reject position
- **Most commonly used standards/guidelines**
  - NMEA
  - UKOOA
  - IMCA

- **Guidelines are not intended to be used as a specifications**
  - left to the discretion of the supplier/operator/user whether or not to follow the guideline

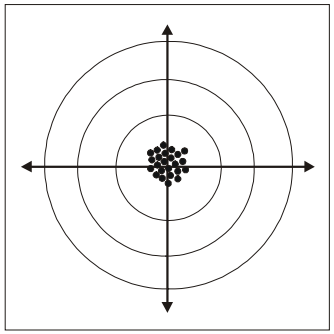
National Marine Electronics Association

- **NMEA standards designed to**
  - Facilitate public interest in interconnection & interchange ability of equipment
  - Minimize the misunderstanding & confusion between manufacturers
  - Assist purchasers in selecting compatible equipment
- **The main standards used for positioning**
  - NMEA 0183
    - Including High Speed (HS) standard
  - NMEA 2000®

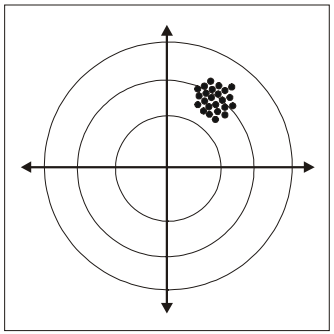
NMEA

- **GPS receiver communication is defined within the specification**
  - NMEA 0183 commonly used within DP equipment and sensors that connect to the DP system
- **NMEA 0183 Standard**
  - Single talker and multi-listener
  - Universal method for data exchange between 2 devices
  - Recommends a physical layer
  - Open to miss-interpretation
- **Latest version is 3.01 (released Jan. 2002)**

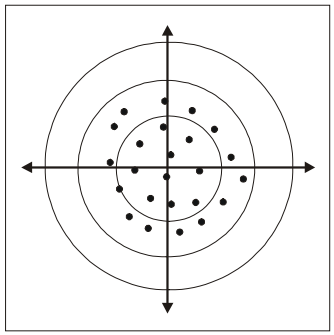
- **UKOOA issued guidelines for the use of DGPS in offshore surveying in 1994**
  - sets out what is generally regarded as good practice but are not mandatory and operators are free to adopt different standards
  - recommendations aimed at survey users but could equally be applied to DP applications
  - particularly when high accuracy positioning systems are used
  - provide the user with confidence that the position calculated is accurate & reliable



Precise & Accurate



Precise & Inaccurate



Low Precision

- **Guidelines presents a set of test statistics and quality measures**
  - essential to assess the precision and reliability of each position in order to ensure the quality of the calculated position
- **Following test statistics are recommended**
  - w-test used to detect outliers
  - F-test to verify the model which is being used to account for ‘errors’ in the DGPS observations
- **Following quality measures are recommended**
  - Error Ellipse an approximate graphical representation of the positional standard deviation in two dimensions
  - External Reliability the effect of the maximum MDE (marginally detectable error) on the computed position

- **IMCA guidelines on using DGPS as a position reference in DP control systems issued 1997**
- **The main objectives of the were:**
  - to assist optimum DGPS use and improved reliability
  - to make some realistic proposals for improved DGPS use in DP i.e.
    - to propose standard DGPS interface to DP control systems
    - to improve the use of DGPS Quality Control (QC) indicators in DP activities
  - to provide a basis on which DP classification authorities may formally approve (not merely accept) DGPS as a DP position reference
  - distil current best practices into guidance on the optimum use of DGPS in DP activities, and therefore further improve DP users' confidence in DGPS

IMCA - DQI

- **Definition of new message format to provide a consistent approach for interfacing DP systems**
  - Proposed message format based on NMEA GGA message including a DGPS Quality Indicator (DQI) to indicate whether the position was acceptable

DQI	Status of Solution (see note 1)	Precision (see note 2)	Comments (see note 3)
0	Failed Solution	N/A	-
1	Uncorrected	N/A	Solution obtained but no differential
2	Corrected position but no redundancy	N/A	Minimum DGPS solution
3	Corrected position; Redundancy of 1	Poor	Poor Dilution of Precision (DOP)/geometry
4	Corrected position; Redundancy of 1	<10m	Adequate DOP/geometry
5	Corrected position; Redundancy of >1	<10m	Ability to reject outlier; Poor DOP/geometry
6	Corrected position; Redundancy of >1	<10m	Ability to reject outlier; Gradual improvement in geometry/DOP
7	Corrected position; Redundancy of >1	<4m	Ability to reject outlier; Gradual improvement in geometry/DOP
8	Corrected position; Redundancy of >1	<2m	Ability to reject outlier; Gradual improvement in geometry/DOP
9	Corrected position; Redundancy of >1	<0.5m	Ability to reject outlier; Gradual improvement in geometry/DOP

Notes:
1. Prerequisite is a successful solution with a valid statistical test
2. Confidence regions are 95%
3. Assumes improving DQI; if DQI value is worsening, read gradual deterioration

Considerations for DP Applications

- **The NMEA standard provides a good interface standard for DP systems and is commonly used**
  - Typically utilise the GGA sentence which provides a position to the DP which has limited quality information about the calculated position
  - Position references of different accuracies can be used within a DP system so it is important that quality information is available so that the DP can process and weight the position solution correctly

- **Presently there is no standard or message format that has been universally adopted by the DP community**
  - Message types vary between DP manufacturers
  - Legacy DP systems require old format message types e.g. Syledis format.

Position Output Strings - GGA

Veripos Standard (L1 DGPS ~1-2m accuracy)

```
$GPGGA,213137.00,5707.7189993,N,00204.7508917,W,2,08,1.0,25.46,M,50.28,M,9.2,1003*6E
```

Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGGA,213137.00,5707.7189758,N,00204.7509600,W,2,08,1.0,25.62,M,50.28,M,22.0,0069*5F
```

Position Output Strings - GLL

Veripos Standard (L1 DGPS ~1-2m accuracy)

```
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```

Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGLL,5707.7189758,N,00204.7509600,W,213137.00,A,D*78
```

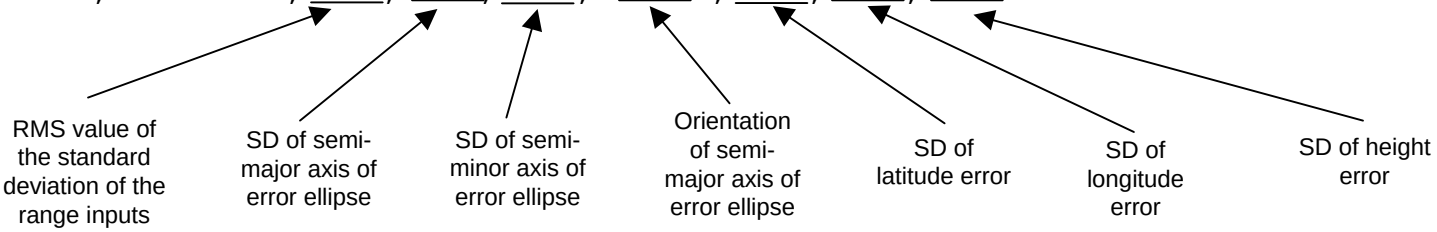
Position Output Strings

Veripos Standard (L1 DGPS ~1-2m accuracy)

```
$GPGGA,213137.00,5707.7189993,N,00204.7508917,W,2,08,1.0,25.46,M,50.28,M,9.2,1003*6E

$GPGLL,5707.7189993,N,00204.7508917,W,213137.00,A,D*79

$GPGST,213137.00,1.37,0.63,0.32,165.25,0.35,0.62,1.12*66
```



Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
$GPGGA,213137.00,5707.7189758,N,00204.7509600,W,2,08,1.0,25.62,M,50.28,M,22.0,0069*5F

$GPGLL,5707.7189758,N,00204.7509600,W,213137.00,A,D*78

$GPGST,213137.00,0.28,0.03,0.02,0.42,0.02,0.03,0.05*6F
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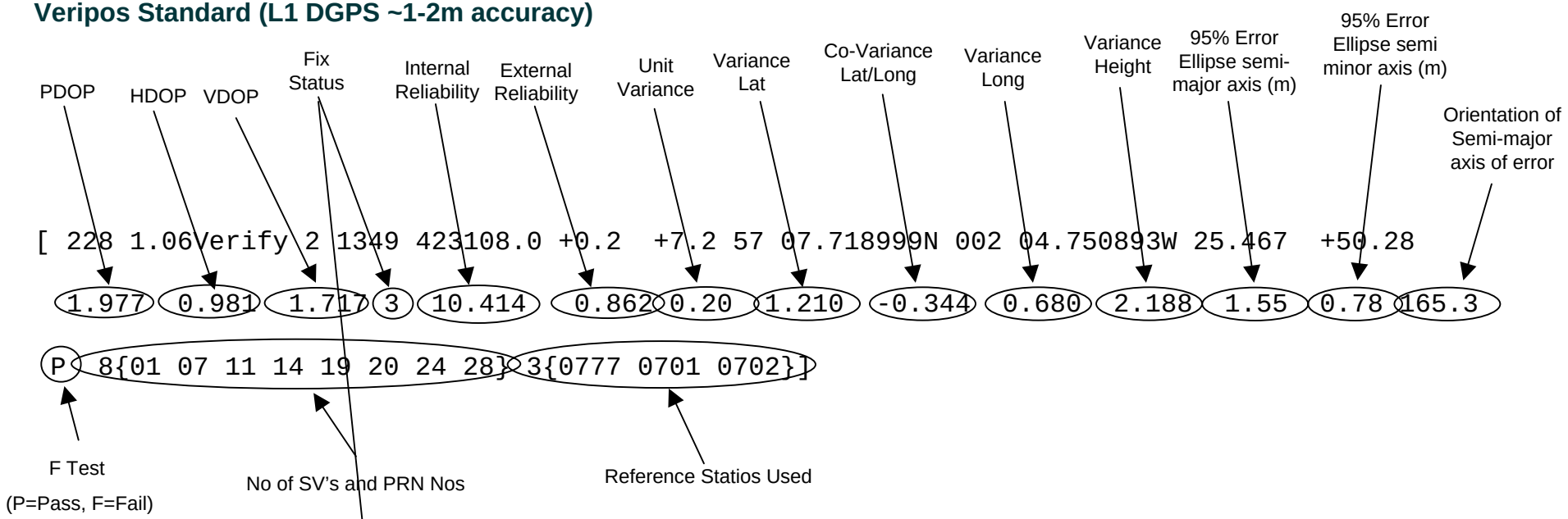
Position Output Strings – Veripos UKOOA

Veripos Standard (L1 DGPS ~1-2m accuracy)



Veripos Ultra (L1/L2 PPP ~0.1-02m accuracy)

```
[ 218 1.06Verify 1 1349 423108.0 +0.2 +20.0 57 07.718977N 002 04.750959W 25.623  +50.28
  1.977  0.981  1.717 7  4.182   0.100 0.49  0.052  -0.002  0.041  0.100  0.06  0.05 179.8
P  8{01 07 11 14 19 20 24 28} 1{0069}]
```

Conclusions

- It is evident that there is a multitude of different output strings available for use in DP systems and no consistent approach or standard
- With the advances in positioning technology it is becoming clear that there is a lack of status and quality information being made available to the DP control systems to allow better modelling and weighting of the position solutions
- GNSS is important for DP operations and with the advances in positioning technology it is always a reference that is going to be used so more information on the generated position will be beneficial
- The standards that exist need to be updated to reflect recent recent improvements in satellite navigation performance

Conclusions

- **It seems sensible to define a new standard which is universally adopted**
  - provide the necessary GNSS system status and quality information to permit better modelling
- **The current IMCA and UKOOA documents are only guidelines and are not intended to be used as a specifications**
- **With such a safety critical aspect then perhaps the guidelines should be reviewed or re-written in consultation with the key players in the DP industry so that they become specifications for both the DGNSS supplier and DP system manufacturers**
- **Sat Nav advances will see new positioning solutions using up to 4-6 satellite constellations – so knowing the quality of the solution will be ever more important**

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