TOTAL
COMMITTED TO BETTER ENERGY

DGNSS & GNSS VERSUS ITRF CAS CONCRETS

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TOTAL E&P

DGNSS AND ITRF

- C&C Technologies
  - C-NavC1 : PPP from JPL network stations
  - Coordinates of the reference stations are computed on a daily basis

  →ITRF2005 epoch of the measurement

  - C-NavC2 : PPP from proprietary network stations
  - Coordinates of the reference stations are computed on a daily basis

  →ITRF2008 epoch of the measurement

DGNSS AND ITRF

- FUGRO
  - StarFix Plus, L1 & HP : DGPS or DGNSS from proprietary network stations
  - Coordinates of the reference stations are computed on a yearly basis or when the coordinates of the station moved more than 1cm.

  →ITRF2008 epoch of the year of measurement

  - StarFix XP : PPP from JPL network stations
  - Coordinates of the reference stations are computed on a daily basis

  →ITRF2005 epoch of the measurement

  - StarFix G2: PPP from proprietary network stations
  - Coordinates of the reference stations are computed on a daily basis

  →ITRF2008 epoch of the measurement

DGNSS AND ITRF

- VERIPOS
  - Standard, Standard 2 & Standard Plus : DGPS or DGNSS from proprietary network stations
  - Coordinates of the reference stations are computed on a yearly basis or when the coordinates of the station moved more than 1cm.

  →ITRF2008 epoch of the year of measurement

  - Ultra: PPP from JPL network stations
  - Coordinates of the reference stations are computed on a daily basis

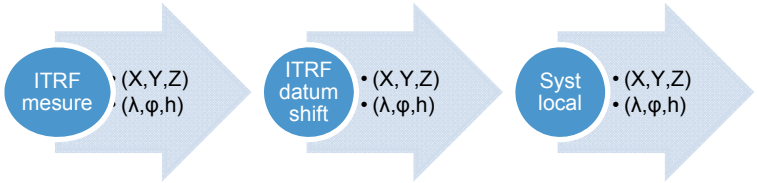
  →ITRF2005 epoch of the measurement

  - Apex & Apex 2: PPP from proprietary network stations
  - Coordinates of the reference stations are computed on a daily basis

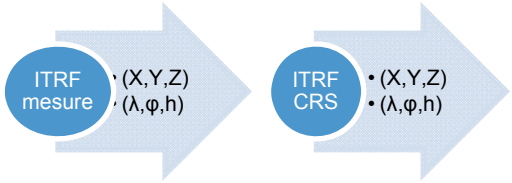
  →ITRF2008 epoch of the measurement

COORDINATE REFERENCE SYSTEMS

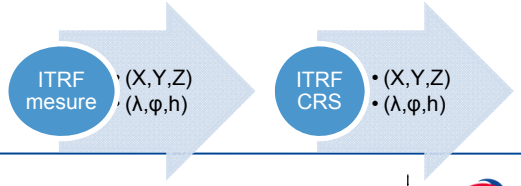
- "Local" Geodetic system : Example the use of CAMACUPA in ANGOLA
  - A transformation is necessary to transfert GNSS coordinates into CAMACUPA CRS



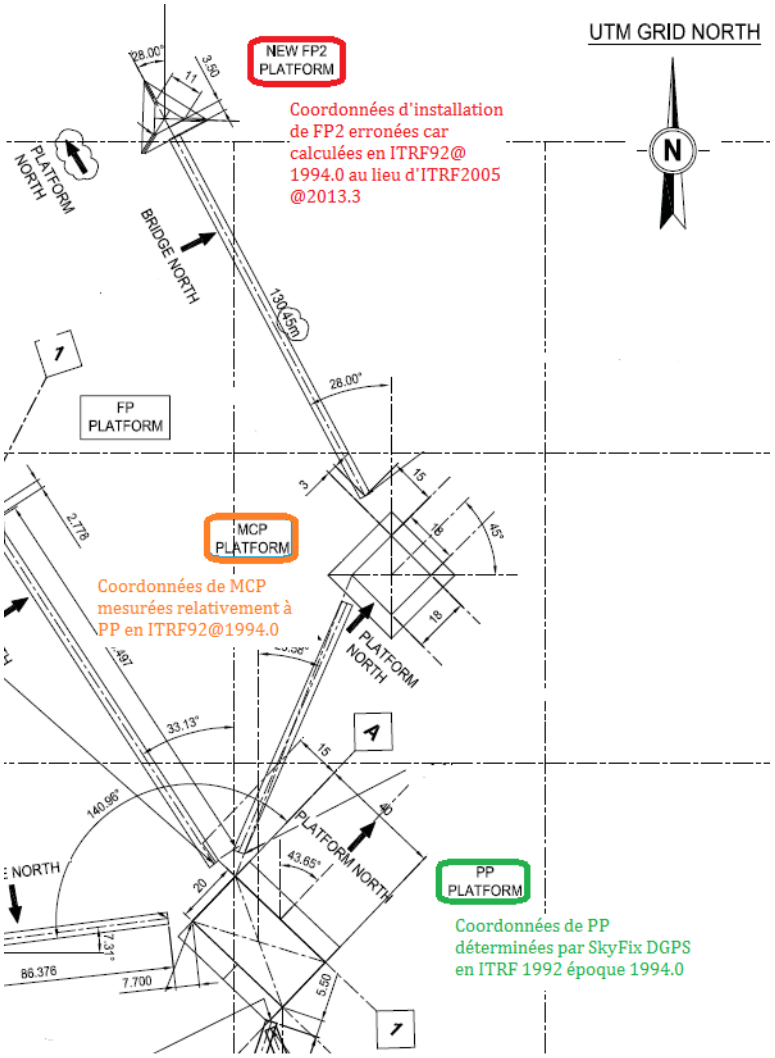
- Official geodetic system already tied to ITRF : Example of SIRGAS2000 in BRAZIL
  - Tied to ITRF2000, epoch 2000.4



- New Geodetic system tied to ITRF : Example in MAURITANIA desert where no benchmarks from "Local" Geodetic system are available.
  - Tied to ITRF2008, epoch of the measurement of the geodetic network



CASE STUDY (MYANMAR)



- Official CRS used by TOTAL offshore Myanmar is MOTTAMA 1992 which corresponds to ITRF91 epoch 1994.25
- PP and MCP have been installed in 1997
- Coordinates for MCP and PP have been computed using DGPS technique (SKYFIX) in ITRF92 epoch 1994.0
- A new jacket FP2 has to be installed
- The bridge between FP2 and MCP is already built.
- Therefore the installation tolerance is very conservative : +/- 1m

TRANSFORMATIONS

- From ITRF measurement to latest ITRF realization (2008) at epoch of CRS by applying velocities (in our case from ITRF2008 epoch 2013 to ITRF2008 epoch 1994
  - Using the UNAVCO plate motion calculator
  - Using its own velocity model computing with IGS station in the vicinity

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{T0} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{Tmesure} + \begin{bmatrix} V_X \\ V_Y \\ V_Z \end{bmatrix} * (T_0 - T_{mesure})$$

- From ITRF 2008 epoch 1994 to ITRF of the CRS
  - Using official transformation parameters computed and published by IGN

→Warning : These parameters are computed at epoch 2000

- From ITRF91 epoch 2000 to ITRF91 epoch 1994.25
  - Using the transformation parameters “rates”

$$\begin{bmatrix} Tx \\ Ty \\ Tz \\ D \\ Rx \\ Ry \\ Rz \end{bmatrix}_{T0} = \begin{bmatrix} Tx \\ Ty \\ Tz \\ D \\ Rx \\ Ry \\ Rz \end{bmatrix}_{T\,référence} + \begin{bmatrix} \dot{T}x \\ \dot{T}y \\ \dot{T}z \\ \dot{D} \\ \dot{R}x \\ \dot{R}y \\ \dot{R}z \end{bmatrix}_{T\,référence} * (T_0 - T_{référence})$$

Transformation parameters from ITRF2008 to past ITRFs.

SOLUTION	Tx	Ty	Tz	D	Rx	Ry	Rz	EPOCH
UNITS---------->	mm	mm	mm	ppb	.001"	.001"	.001"	
	.	.	.	.	.	.	.	
RATES	Tx	Ty	Tz	D	Rx	Ry	Rz	
UNITS---------->	mm/y	mm/y	mm/y	ppb/y	.001"/y	.001"/y	.001"/y	
ITRF2005	-2.0	-0.9	-4.7	0.94	0.00	0.00	0.00	2000.0
rates	0.3	0.0	0.0	0.00	0.00	0.00	0.00	
ITRF2000	-1.9	-1.7	-10.5	1.34	0.00	0.00	0.00	2000.0
rates	0.1	0.1	-1.8	0.08	0.00	0.00	0.00	
ITRF97	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF96	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF94	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF93	-24.0	2.4	-38.6	3.41	-1.71	-1.48	-0.30	2000.0
rates	-2.8	-0.1	-2.4	0.09	-0.11	-0.19	0.07	
ITRF92	12.8	4.6	-41.2	2.21	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF91	24.8	18.6	-47.2	3.61	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF90	22.8	14.6	-63.2	3.91	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF89	27.8	38.6	-101.2	7.31	0.00	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	
ITRF88	22.8	2.6	-125.2	10.41	0.10	0.00	0.06	2000.0
rates	0.1	-0.5	-3.2	0.09	0.00	0.00	0.02	

CASE STUDY ERRORS

- Two “errors” have been made

- When computing PP and MCP coordinates. The coordinates computed in ITRF92 epoch 1994.0 should have been transformed into ITRF91 epoch 1994.25 (official CRS)

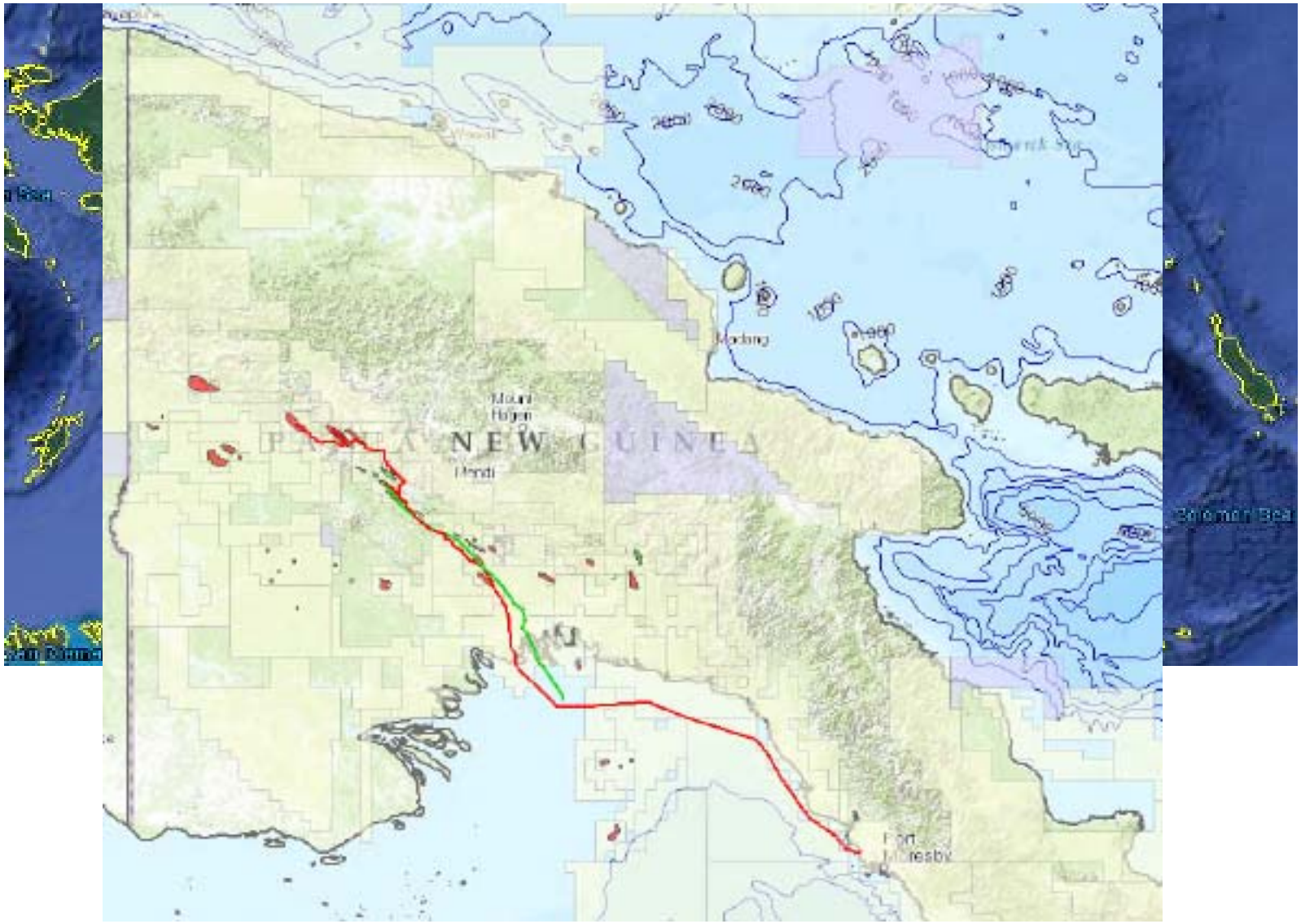
  → Error: 2 cm

- When computing new FP2 coordinates the ITRF2008 epoch 2013.15 has been used

  → Error: 49 cm

Installation Tolerance was only +/- 1m

CASE STUDY (PAPOUASIE NOUVELLE GUINEE)



CASE STUDY (PAPOUASIE NOUVELLE GUINEE)

- Australian Geodetic Datum 1966 (AGD66)
  - Matérialisé par l'armée Australienne et utilisé depuis les années 1960

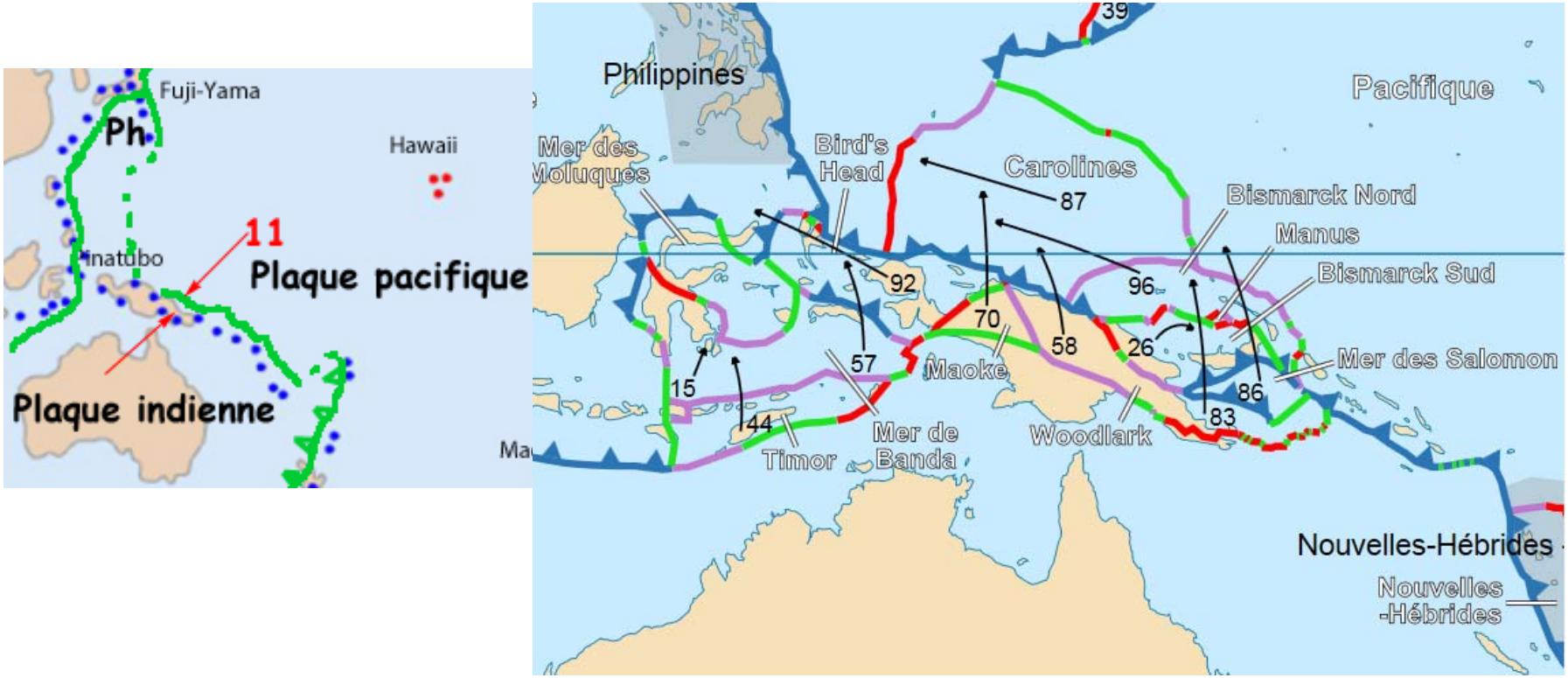
- Papua New Guinea Geodetic Datum 1994 (PNG94)
  - Datum officiel depuis 2000
  - Réalisation ITRF92 epoch 1994.0
  - Réseau ordre 0 de 14 stations matérialisées et observées en 1993 / 1994

- ITRF2005
  - Utilisé par des compagnies et contacteurs au moyen de rattachement aux stations IGS aux alentours

- ITRF2008
  - Utilisé par des compagnies et contacteurs au moyen de rattachement aux stations IGS aux alentours : LAE1 (PNG), TOW2 (Townsville, Australie) et DARW (Darwin, Australie)

CASE STUDY (PAPOUASIE NOUVELLE GUINEE)

- PNG est situé à la limite des 2 plaques Indienne et Pacifique



- La vitesse de déplacement dans notre zone d'intérêt est de
  - 34 mm/an en Easting
  - 51 mm/an en Northing

CASE STUDY (PAPOUASIE NOUVELLE GUINEE)

- Travailler en PNG94
  - Etablir un réseau de points géodésiques rattaché au réseau ordre 0 PNG94
  - Advantage : All survey and positioning operations on shore shall be carried out from these benchmarks (using GNSS RKT technique) and so the coordinates shall be known in PNG94 (ITRF92 at epoch 1994.0). All georeferenced data we have received so far can be used as such without any transformation.
  - Drawback : when using DGNSS or GNSS absolute positioning (mainly offshore but also for the LIDAR survey) the coordinate shall need to be transformed from ITRF2014 epoch of measurement into the PNG94 (ITRF92 at epoch 1994.0). This transformation needs to be done with specific software (taking into account tectonic site velocity for example) which are not implemented into our standard geosciences software such as SISMAGE, TDESK or ARCGIS.

CASE STUDY (PAPOUASIE NOUVELLE GUINEE)

- Travailler en ITRF14
  - We implement and measure a geodetic network made of benchmarks and we tie it to the ITRF2014 epoch of measurement (for example mid of this year : epoch 2016.5) thus defining a new CRS.
  - Advantage : All survey and positioning operations on shore shall be carried out from these benchmarks (using GNSS RKT technique) and so the coordinates shall be known in ITRF2014. When using DGNSS or GNSS absolute positioning (mainly offshore but also for the LIDAR survey) the coordinate shall be usable without transformation.
  - Drawback : All georeferenced data we have received so far shall need to be transformed into this ITRF2014. This transformation needs to be done with specific software (taking into account tectonic site velocity for example) which are not implemented into our standard geosciences software such as SISMAGE, TDESK or ARCGIS. The defined CRS shall be different that the official one.

End of the Presentation

Thank You

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