March, 2016

This slide set is provided as a general set of PowerPoint slides, with basic TPOS 2020 information, including impetus, project structure, guiding scientific questions and general project management overview.

This is a resource for you to present standard information, but is not likely to be in the order in which you would like to present. Please modify, rearrange, and enhance for your own presentation needs.

If there are specific areas of information that you think should be added or addressed, please email info@tpos2020.org.
The TPOS 2020 project
(T.P.O.S. is the observing system, TPOS 2020 the project)

The Tropical Pacific Observing System 2020 project (TPOS 2020) is an international effort to rethink the T.P.O.S.

We now have new tools and new issues....

TPOS 2020 was defined by an international workshop in January 2014, La Jolla, CA.

What in situ observations do we need for the next decades?

www.tpos2020.org
From crisis to opportunity:
Can we build a more effective, modern and robust observing system?

The TPOS 2020 project arose from the 2014-2014 crisis of TAO, and JAMSTEC’s withdrawal from TRITON, the time became ripe to reexamine the whole system.

TRITON stations marked by an ‘X’ have already been removed.

Number of TAO moorings reporting data

2014 TPOS Workshop
La Jolla, CA
ENSO Drove the Original Observing System

- El Niño of 1982-83 – and the failure to recognize it until very late – was the impetus for the TOGA observing system.

- Original TAO designed to detect equatorial waves, then the key issue for diagnosis and prediction.

- TOGA observations led to an explosion of ideas in the 80s-90s that established our understanding of ENSO as an intrinsically coupled oscillation.

- Now, those issues are well understood, and we face a different set of problems.

Figure 2. In situ components of the Tropical Ocean Global Atmosphere (TOGA) observing system at (top) the start of TOGA in January 1985 and (bottom) the end of TOGA in December 1994. Color coding indicates the moorings (red symbols), drifting buoys (orange arrows, one for approximately every 10 drifters), ship-of-opportunity lines (blue), and tide gauges (yellow). After McPhaden et al., 1998
ENSO Diversity Presents New Challenges

• Today’s observing and forecast systems must adapt to today’s issues
• The lessons of the past 3 decades is ENSO diversity
• The potential for future surprises is high

• Our foremost goal remains to improve the ENSO forecasts, and thus increase seasonal prediction skill
But, it’s not just ENSO

- Changes in tropical atmospheric heating leads to a variety of tropical disturbances that radiate to the extratropics.
The Tropical Pacific Observing System has grown to include many platforms, and was a template for other basins.
Evolution is essential for both practical and scientific reasons:

- The ENSO observing system was designed in the 1980s-90s:
  - Based on the scientific challenges of that era,
  - Largely on the technology from that era,
  - It is an independent collection of pieces.

- The crisis of TAO in 2012-14 showed the risk to this system that underpins our seasonal forecasting and tropical research.

- We are now in a position to improve the system by taking full advantage of present technology (Argo, robotics, satellites), and recent scientific understanding, in a thought-through system.

We will live with what we design for many years, so we will move carefully.
TPOS 2020 Goals

- To redesign and refine the T.P.O.S. to observe ENSO and advance understanding of its causes,
- To determine the most efficient and effective observational solutions to support prediction systems for ocean, weather and climate services,
- To advance understanding of tropical Pacific physical and biogeochemical variability and predictability.

TPOS 2020 will provide evidence-based, vetted advice pointing to an intelligent evolution of the observing system.
TPOS 2020 Organization

- TPOS 2020 is an international project under GOOS, but is effectively appointed by the 2014 workshop
The TPOS 2020 Steering Committee

Members

Billy Kessler (Co-Chair)(NOAA/PMEL, USA)
Neville Smith (Co-Chair)(retired, BOM, Australia)
Ken Ando (JAMSTEC, Japan)
Dake Chen (SIO, China)
Sophie Cravatte (IRD, France)
Tom Farrar (WHOI, USA)
Harry Hendon (BOM, Australia)
Dong-Chull Jeon (KIOST, Korea)
Arun Kumar (NCEP, USA)
Bill Large (NCAR, USA)
Yukio Masumoto (U. Tokyo, Japan)
Dean Roemmich (Scripps, USA)
Pete Strutton (U. Tasmania, Australia)
Ken Takahashi (IGP, Peru)
Weidong Yu (FIO, China)

2 SC Meetings held

➢ 6-9 October, 2014 at KIOST in Seoul, Korea

➢ 14-17 October, 2015 at CSIRO in Hobart, Tasmania/Australia
Backbone Task Team
Co-chaired by Sophie Cravatte (IRD)
and Susan Wijffels (CSIRO)

**Project Function:**
Through an integrated approach the Backbone TPOS will achieve its objectives through a combination of in situ and remote sensing approaches, augmented as appropriate with advice from models and data assimilation. Sampling for the Backbone has as its goal to:

(a) Observe and quantify the state of the ocean, on time scales from weekly to interannual/decadal
(b) Provide data in support of, and to validate and improve, forecasting systems
(c) Support calibration and validation of satellite measurements
(d) Advance understanding of the climate system in the tropical Pacific, including through the provision of observing system infrastructure for process studies
(e) Maintenance and, as appropriate, extension of the tropical Pacific climate record.

Point of Contact:
Associate Project Manager, Ana Lara-Lopez-> Ana.Lara@utas.edu.au
Backbone Task Team
Co-chaired by Sophie Cravatte (IRD) and Susan Wijffels (CSIRO)

Progress:

➢ Held face-to-face meeting at IRD in New Caledonia, to explore the limitations of the current TPOS, and to begin drafting requirements and recommendations for the sustained observing system

➢ First draft of 2016 Interim Report will be produced in March, 2016

➢ Draft will go through an internally selected review committee, and revisions will be made between April and June, 2016

➢ A consultative draft will be released to the community in July, 2016 and a second order review will take place leading up to the annual SC meeting in late 2016

➢ The final version of the 2016 Interim report will contain initial recommendations for the design of the backbone OS as well as plans for the various initiatives to be sponsored by TPOS 2020.

Point of Contact:
Associate Project Manager, Ana Lara-Lopez -> Ana.Lara@utas.edu.au
Planetary Boundary Layer Task Team
Co-chaired by Tom Farrar (WHOI) and Meghan Cronin (NOAA/PMEL)

Project Function:
The Planetary Boundary Layer Task Team will tackle their objectives through ocean surface and near-surface process studies. The role of this task team is to identify which observing system requirements are best met via a sustained observing effort (>5 years) and which can be addressed with specific short-term process campaigns.

(a) Formulate strategy and sampling requirements to estimate air-sea fluxes over short (hourly) time scales across key ocean and climate regimes
(b) Develop recommendations about needed boundary layer measurements including spatial and temporal sampling requirements, particularly to resolve the diurnal cycle
(c) Consider a subset of regimes where direct eddy-correlation approaches might be used
(d) Liaise with existing and developing ocean satellite and modelling community on efficiently meeting their present and future requirements for ocean surface data
(e) Engage biogeochemical and ecosystem experts to ensure the needs of key gas exchange calculations are met.

Point of Contact:
Associate Project Manager, Lucia Upchurch -> lucia.upchurch@noaa.gov

www.tpos2020.org
Planetary Boundary Layer Task Team
Co-chaired by Tom Farrar (WHOI) and Meghan Cronin(NOAA/PMEL)

Progress:
➢ Designed and distributed an extensive questionnaire to the PBL community, receiving widespread input and recommendations for the backbone design necessary for PBL observations
➢ Leading three sections of the Interim Report
➢ Using the ‘strawman’ concept
  ➢ Investigating joint activities with Years of the Maritime Continent (YMC) such as mooring enhancements and shipboard observations
  ➢ Increase understanding of the diurnal cycle
  ➢ Increase observations for equatorial upwelling and mixing physics in the eastern Pacific
➢ A double ITCZ process study originated with the PBL TT but is now being spearheaded primarily by the EP TT.

Point of Contact:
Associate Project Manager, Lucia Upchurch -> lucia.upchurch@noaa.gov
Biogeochemistry Task Team  
Co-chaired by Pete Strutton (Univ. of Tasmania)  
and Adrienne Sutton (NOAA/PMEL)

Project Function:
The Biogeochemistry task team will evaluate and recommend the most promising foci for observation. The team will begin with carbon biogeochemistry as its core scientific concern. The team will consider primary productivity but not higher trophic levels.

(a) Develop strategies and design plans for the biogeochemical contributions  
(b) Provide guidance to the Backbone TT for biogeochemical requirements needed in the redesigned TPOS  
(c) Determine the temporal and spatial scales required for the observing system  
(d) Provide a prioritized list of variables that will be measured as part of the BGC observing network  
(e) Guide the implementation of BGC observations and evaluate new technologies and required process studies

Point of Contact:  
Associate Project Manager, Ana Lara-Lopez -> Ana.Lara@utas.edu.au
Biogeochemistry Task Team
Co-chaired by Pete Strutton (Univ. of Tasmania) and Adrienne Sutton (NOAA/PMEL)

Progress:
➢ Distributed a questionnaire for BGC parameters (7 questions)
➢ So far, 17 scientists have responded
➢ The team continues to create a prioritization list of BGC variables, to explore the spatial and temporal resolution needed for those variables, and to identify new technologies to make these observations
➢ The team plans an analysis of model data to determine the best longitudes to focus process studies on source waters to the equatorial undercurrent

Point of Contact:
Associate Project Manager, Ana Lara-Lopez -> Ana.Lara@utas.edu.au
Eastern Pacific Task Team
Co-chaired by Ken Takahashi (Instituto Geofísico del Perú) and Yolande Serra (University of Washington)

Project Function:
The Eastern Pacific Task Team will define observations necessary to the backbone observing system, as well as facilitate capacity building for improved sustained observing capability and facilitate the development of a regional research project that guides the sustained observing system.

(a) Determine the observational requirements, including time and space scales that should be resolved.

(b) Develop observational strategies and design plans for the region.

(c) Provide guidance as required to the Backbone Observing System Task Team and, as required, other Task Teams on strategies and plans for the region.

(d) Foster interaction and collaboration between the TPOS and other international programs that have an observational focus in the tropical eastern Pacific boundary region.

(e) Provide guidance on implementation and explore potential opportunities to collaborate with regional institutions for the implementation and maintenance of TPOS and its national components, and to evolve process-oriented boundary measurements towards a sustained system.

Point of Contact:
Associate Project Manager, Lucia Upchurch, lucia.upchurch@noaa.gov

www.tpos2020.org
Eastern Pacific Task Team
Co-chaired by Ken Takahashi (Instituto Geofísico del Perú) and Yolande Serra (University of Washington)

Progress:
➢ An initial strawman was proposed by the TT to address the double ITCZ
➢ To increase community input, the team has initiated a questionnaire to collect input from the community around the double ITCZ strawman/process study
➢ Contributing to the 2016 Interim Report

Point of Contact:
Associate Project Manager, Lucia Upchurch, lucia.upchurch@noaa.gov
Western Pacific Task Team
Co-chaired by Ken Ando (JAMSTEC) and Janet Sprintall (Scripps)

Project Function:
The goal of the WP-TT is to identify the significant features of the western Pacific circulation and air-sea exchange, and to oversee and develop an integrated strategy towards an observing system that resolves these features for the purpose of applications of the ocean observing system (e.g. typhoon forecasting, climate forecasting and research).

a) Foster interaction and collaboration between the TPOS and other international programs
b) Determine the observational requirements for over the next few decades, including time and space scales
c) Develop observational strategies and design plans for the region, taking into account, as appropriate, the readiness of technology and feasibility of measurements
d) Provide guidance as required to the Backbone Task Team and, as required, other Task Teams on strategies and plans for the region.
e) Seek mechanisms for improved cooperation and coordination of logistics and ship time for the region.
f) Provide guidance on implementation and explore potential opportunities to engage with and collaborate with regional institutions for the implementation and maintenance of TPOS and its national components, and to evolve process-oriented boundary region measurements towards a sustained system
g) Promote and ensure that public data availability and distribution plans are included in all proposed observational efforts

Point of Contact:
Project Manager, Andrea McCurdy, amccurdy@oceanleadership.org

www.tpos2020.org
Western Pacific Task Team
Co-chaired by Ken Ando (JAMSTEC) and Janet Sprintall (Scripps)

Progress:
➢ Began as a sub-project writing team to develop regional project plan (drawing on national/regional activities/plans)
➢ After inaugural meeting proposed to be approved as a Task Team
➢ Terms of Reference approved at SC-2
➢ Face to Face meeting at Ocean Sciences 2016
➢ Contributing to the 2016 Interim Report

Point of Contact:
Associate Project Manager, Lucia Upchurch, lucia.upchurch@noaa.gov

www.tpos2020.org
Modelling and Data Assimilation Task Team
Co-chaired by Arun Kumar (NOAA/NCEP) and Eric Guilyardi (IPSL/LOCEAN & NCAS Climate)

Project Function:
The Modelling and Data Assimilation task team will evaluate the bias and errors in current models to develop a strategy to assimilate key observations to improve models and forecast capabilities.

a) To develop strategies for coordinated modelling and assimilation activities for designing and planning the future TPOS observing systems, such as those proposed by the other task teams.
b) To identify pathways that will contribute to improved understanding of systematic errors, their causes, and to subsequent model improvements, especially through promotion of joint activities with other bodies that have mandates to improve models.
c) To contribute data assimilation insights into the identification of observational requirements for forecast systems.
d) To provide guidance on the assessment of the impact of observational data on analysis and forecasts through systematic continuous evaluation (metrics and process-oriented diagnostics), OSEs, and OSSEs, especially using the multi-model approach.
e) As appropriate, recommend strategies for model initialization that will promote the efficient use of TPOS information.
f) To provide recommendations on improving coordination among centers currently engaged in ocean analysis on the uptake of observational data.

Point of Contact:
Associate Project Manager, Lucia Upchurch -> lucia.upchurch@noaa.gov

www.tpos2020.org
Modelling and Data Assimilation Task Team  
Co-chaired by Arun Kumar (NOAA/NCEP) and Eric Guilyardi (IPSL/LOCEAN & NCAS Climate)  

Progress:  
➢ The Modelling and Data Assimilation task team held an inaugural teleconference in January, 2016  
➢ Development of a work plan is underway  
➢ The group will interact with other working groups looking to address similar problems through engagement with GODAE Ocean View, CLIVAR/GSOP, WCRP and others  
➢ Potential workshop on to share best practices for model initialization, as well as parameterization development and tuning by systematic increments, to work through systematic model biases  
➢ A real time Multiple Ocean Reanalysis Intercomparison activity being led by Yan Xue and Magdalena Balmaseda is supported by the M&DA TT  

Point of Contact:  
Associate Project Manager, Lucia Upchurch - lucia.upchurch@noaa.gov  

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TPOS 2020: 2015 Progress

➢ “Strawman” approach → initial ideas, design options.
➢ Further elaborate four of the “strawmen”:
  • Joint study with Years of the Maritime Continent,
  • The Diurnal Cycle (effects on multiple time scales),
  • Equatorial Pacific upwelling and mixing physics, and
  • Double ITCZ process study.
➢ Community survey → Strengthened engagement.
➢ Options for Tropical Pacific Observing System Backbone/Basic OS
➢ Consideration to priorities for modelling and data assimilation, integration of satellite contributions into the design, biogeochemical science questions and strategy for the Western Pacific.

Key Message: Scientific aspects progressing well
**TPOS 2020: 2016 Actions**

**Interim Report Draft 1**
- March, 2016
- Backbone task team members and other Task Team co-chairs provide authorship
- Internal TPOS research community review

**Interim Report Draft 2**
- July, 2016
- Steering Committee will lead during this external review process.
- Reviewers include the research and operational communities, as well as those identified through the Resources Forum

**Interim Report-Released**
- December, 2016
- Interim Report released
- Provides stakeholders and agencies guidance for the requirements for the sustained T.P.O.S.
Evolution → TPOS @ 2020

2020

Final Design

TPOS @ 2020

TPOS 2020 Spinoffs

2018

Mid-term Report

Refinement

Pilots

2016

Interim Report

Backbone

Strawmen

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Implications of Interim Report

• Orderly, systematic transparent review
  – First order draft to science experts Feb/Mar 2016
  – Second order draft stakeholder review July 2016
  – Final and Approval by TPOS SC last week Oct 2016
  – Publish late 2016

• Interim Report is more than Backbone/Basic OS
  – There will be aspects of the design that will follow later
    • E.g. Biogeochemistry; Western/Eastern Pacific initiatives

• Implications for implementation (next slide)

  Key message: Evidence-based design and review
TPOS 2020: Transition

2016

Interim Report

2018

Mid-term Report

Final Design

2020

Establish

Interim Impl.

Handover of responsibility

TPOS 2020 Transition Team → Permanent Coordination Mechanism

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TPOS 2020 Goals

- To redesign and refine the T.P.O.S. to observe ENSO and advance understanding of its causes,
- To determine the most efficient and effective observational solutions to support prediction systems for ocean, weather and climate services,
- To advance understanding of the tropical Pacific physical and biogeochemical variability and predictability.

TPOS 2020 will provide evidence-based, vetted advice pointing to an intelligent evolution of the observing system.
Changes? (premature to say but…..)

Use technology where its capabilities match the needs

It’s likely that a **moored array** will continue to be necessary:

- TAO time series calibrate satellite winds, SST, …
- Near-equatorial current measurements are vital.
- The long records from TAO are a key climate indicator.
- High-frequency sampling aids interpretation of coarser measurements.
- Co-located ocean-atmosphere sampling to diagnose the (poorly-modeled) interaction of the two boundary layers.
We have tools that did not exist when TAO was designed:
• Argo floats, extensive satellite sampling, other autonomous vehicles.

Argo is improving and complementing existing subsurface sampling:
• Argo has better vertical resolution, better zonal spacing, salinity …
• It is a major part of the TPOS 2020 vision.
• But Argo can’t do the diurnal mixed layer, or the surface met obs.

Satellites should complement in situ sampling.
• This should be fundamental, but it is not yet clear how to effectively overlap and integrate the two kinds of measurements.
What in situ sampling is needed for the next decades?

- Must meet the needs of operational forecast systems-

- Backbone technology must be mature or nearly so-

- Must maintain a credible climate record-
What in situ sampling is needed for the next decades?

1. Beyond supporting prediction, the T.P.O.S. is infrastructure that underpins tropical Pacific research.

   This infrastructure is both material:
   → ships and platforms that make process studies feasible;
   and intellectual:
   → climatologies and regional context for limited-term studies.

What background sampling will CLIVAR process studies need?
Which variables? Where?

2. Changes made now will be in place for decades.

What in situ data will future models need?
Looking back from 2030, what will we wish we had started sampling in 2016?

3. What is the TAO array for?
   → In situ calibration of satellite data (winds).
   → Diagnosis of phenomena that need long time series.
   → Initialization of forecasts.
Guiding Principles

• Do not repeat the mistake of changing observing systems without adequate overlap and evaluation.
• Advance by observing the mechanisms connecting the equatorial thermocline and the free atmosphere. Challenge and guide model improvement.
• Foster a diverse-platform observing system to adequately sample ENSO’s rich multi-scale variability. Integrate tools that did not exist when TAO was designed: Satellites, Argo, new autonomous samplers…
• Beyond its monitoring capability, TPOS should serve as the backbone for essential ancillary and process studies (allowing others to propose and participate).
Engagement

• Distributed Project Office is activity based on SC-approved Engagement Plan
• Engagement through Task Teams is working well
• Initial Project-wide initiatives include:
  – NE Asia
  – WMO – Met Agencies
  – Pacific Islands
  – Americas

Key Message: Two-way and transparent communications
Follow the Project

• Email: info@tpos.org
• Website: www.tpos2020.org
• Twitter: @tpos2020
• Monthly Status Report: Mail list and Website Accessible
Additional Science Slides
The Bjerknes feedback: Fundamental Coupling

Positive feedbacks couple thermocline slope, SST, zonal winds.

The coupling depends on communication links:
- between the thermocline and the surface
- between the free atmosphere and the surface stress/fluxes

(The above is glib and vague about how these links operate ... and so are models)
How does the thermocline communicate with the atmosphere?

The diurnal cycle is surprisingly important ... and its effect depends on background conditions. Can we teach this to models?

Turbulent dissipation during 10 days of 1991
White = Mixed layer
Red = Turbulent ε
TIWE (Lien)

• Much of the work of heat and momentum transmission to the thermocline is accomplished by the diurnal cycle.
• The diurnal warm layer is now thought to be a major factor in developing MJO events.
Boundary regions (western and eastern) will require specific attention:

Examples of issues in the Eastern Pacific (1/2)

Moorings in the Eastern Pacific are important for monitoring and provide continuous climate records in the most dynamic region in the Pacific and are of particular interest to western South America, but are the most vulnerable to vandalism.

Additionally, substantial data exists from western South America but is not available in a timely fashion (in contrast to TAO/TRITON, Argo, etc.).

It is highly desirable to operationally include these observations into TPOS.
Boundary regions (western and eastern) will require specific attention:

Examples of issues in the Eastern Pacific (2/2)

- Predictive skill beyond 3 months continues to be low in the Eastern Pacific.
- Model biases are likely a dominant factor, but need data and process understanding to improve them.

Niño 1+2 SSTA (°C): Observed (red) and NOAA CFS2 6.5-lead forecast (black)

SST (°C) bias in CFSv2 January forecasts initiated in September (1999-2009)

**Kumar et al 2012**

Long-standing and generalized biases in the eastern Pacific are the warm SST bias and the double ITCZ syndrome.

* 120E-80W, normalized by tropical means
The need for multiple platforms

Argo can be used to detect Kelvin waves and their impact on ocean temperature at the Peruvian coast – particularly valuable as the TAO array has been subject to high levels of vandalism in critical regions.

(figure from K. Takahashi)
Models remain a weakness of ENSO prediction

TPOS 2020 will not itself build models, but much of the impact of TPOS data is through models:

Analyses and reanalyses that synthesize diverse data sources, in situ and satellite.

Bad (biased) models can degrade TPOS data products.

One example where models need observational guidance:
The diurnal cycle is surprisingly important for the transmission of surface fluxes to the subsurface ocean. Heat and momentum are communicated downwards via mixing produced by afternoon heating/stratification. Models without these processes have cooler SST and weaker thermoclines (persistent biases).

**Diurnal cycle composite at 2°N, 140°W.**

Wind and current vectors, temperature shading.
Afternoon trapping, then downward propagation of $T$ and $u$ (and implied mixing) into the evening.

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**Fig. 5.** Mean diurnal composite (24 May 2004–7 Oct 2004) of wind (blue vectors), temperature (color shading), and currents relative to 25 m (black vectors). The vector scale is shown at the bottom.

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TPOS 2020 will support limited-term process studies to support model development
CO$_2$ monitoring will be a key part of the new TPOS

Monthly SST, Winds and $f$CO$_2$ from the Equatorial Pacific

30-year record of monthly mean SST and surface ocean $f$CO$_2$
6°N - 10°S, 85°W - 165°E

Monthly dots:
- El Niño
- La Niña
- Neutral

Outgassing decreases during El Niños, but a regime change occurred after 1998:
Overall increase, but smaller ENSO signal.

TPOS 2020 will integrate CO$_2$ monitoring as part of the backbone observing system

after Feely et al., in preparation

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How can we best use evidence-based system design, and how can we measure our success?

OSEs: “Many lives of an observation”
- Calibration of Satellite retrievals
- Model development, tuning, initialization, verification
- Trend detection
- Underpin evolving climatologies
- Process diagnosis

A typical OSE that tests only the initialization step is not a full evaluation, and the results depend on the particular model and its biases.

How can TPOS use OSEs to assess array configurations?

Data-based objective techniques to integrate global high-horizontal-resolution satellite data (SST, SSH) with sparse in situ profiles?

“Armor3D”: Satellites provide mesoscale, in situ tunes for vertical structure and large-scale.
New Platforms for Intermittent and Sustained Observations

- **Saildrone, Surface Mets, up to 200 lb payload capacity**
- **Wave Glider**
- **Argo Global Array**
- **Spray Glider Dive**
- **Next generation buoys**

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Additional Project Management Slides
Project Management “Lite”

• “Lite” Project Management
  • Enough documentation to properly manage, but not too much
  • Highlight:
    • Objectives and breakdown of work
    • Schedules and deliverable
    • Cross-dependencies and risks

• Distributed project management support
  • Washington, D.C. (USA)
  • Seattle, Washington (USA)
  • Hobart, Tasmania (Australia)
  • Qingdao (China)
Distributed Project Office

Project Execution
  • Scope Management
  • Resource Management

Project Management
  • Schedule Management
  • Change Control Management
  • Risk and Opportunity Management
  • Effort and resource Tracking
  • Engagement Action Plan Management
  • Communication Management
    • Work Breakdown Structure (WBS)
    • Integrated Master Schedule (IMS)
    • Monthly Status Report (MSR)
    • Annual Work Plan (AWP)
This is revisited during the annual SC meetings and amended as requested.