Software Architecture and Engineering

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NGGPS Annual Meeting

July 14, 2015

Outline

- Background

- Goals and Objectives

- Gaps

- Next Steps

Background

- ## Advanced Computing Evaluation Committee (AVEC)
  - Began Aug. 2014 to evaluate performance, scalability and software readiness of NGGPS candidate non-hydrostatic dycores

  > ### "NGGPS Level-1 Benchmarks and Software Evaluation"
  > 4/30/2015
  >
  > Michalakes[1], Benson[2], Black[1], Duda[3], Govett[4], Henderson[4], Madden[4], Mozdzynski[5], Reinecke[6], Skamarock[3], Vasic[1]
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  > [1] NOAA National Centers for Environmental Prediction
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  > [2] NOAA Geophysical Fluid Dynamics Laboratory
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  > [3] National Center for Atmospheric Research
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  > [4] NOAA Earth System Research Laboratory
  >
  > [5] European Centre for Medium-Range Weather Forecasts
  >
  > [6] Naval Research Laboratory

- ## Will AVEC continue into Phase-II or be reconstituted as **Software Architecture and Engineering Team**?

SAE Goals and Objectives

- NGGPS Implementation Plan, v1.0 Oct. 2014
  - "...improved software architecture and system engineering."
  - develop a "software architecture and engineered system that maximizes the benefit from HPC"
  - "Building a high-performance, flexible software infrastructure" for ease of use, performance and interoperability
  - "Implementing a community-based model infrastructure" to streamline R2O

- Major SAE task areas
  - Software processes/practices
  - NEMS Readiness
  - HPC readiness
  - Community User On-ramp development
  - Carryover testing from Phase-I

Objective: Software Architecture and Engineering

- Establish processes and best practices for efficiently and reliably managing codes in R2O community environment
  - Specification, development and maintenance of high-quality software for NCEP and contributors
  - Simplification: make NGGPS as easy and straightforward as possible for a visitor or outside user
  - Orderly, transparent source code management policies and procedures
  - Software quality assurance policies and procedures
  - Meaningful, enforceable coding standards
- Common community physics package
  - Standard GFS interface development (NUOPC)
  - Requirements, design and code management for v.2 standalone GFS physics package

Objective: NEMS Readiness

- Three of the five NGGPS candidates already compatible with NEMS or NEMS-like framework
  - Essentially ESMF compatibility: init-run-finalize
  - Use NEMS/ESMF import/export states
  - NEMS I/O, etc.
- Work with by NEMS, Modeling Groups, and OAS Team:
  - Add new NGGPS dycore to NEMS directory structure, build mechanisms,
  - Testing to identify and fix or accommodate outlying incompatibilities
  - Establish mechanisms, policies, procedures for ongoing interaction on development and code maintenance in NEMS framework

Objective: User Community On-Ramp

- Make NGGPS as easy and straightforward as possible for a visitor or outside user
- Simplified, rationale, teachable software infrastructure
  - On-line and in-person tutorial material with step-by-step guidance
  - Comprehensive documentation (technical description and reference manuals) that is kept up to date
  - A helpful and responsive User Help Desk with support archives
  - **WRF User Support is an exemplar**: (http://www2.mmm.ucar.edu/wrf/users/support.html)
- GUI/User Interface
  - NWP Information Technology Environment (NITE)
    - Surveyed ECMWF and UKMO interfaces
    - http://www.dtcenter.org/eval/NITE
    - DTC report 3/31/15 by Bernardet and Carson

Objective: HPC Readiness

- Work with model groups, technical experts, and HPC vendors to provide "abundance" of computing needed for NGGPS

- Performance and scaling
  - Exploit *all* available parallelism ...
    - Task, thread, "fine-grained" (e.g. vector)

    ,,, and deal with lack of parallelism where unavailable.
    - Time dimension is fundamentally sequential
    - **Nesting/mesh** refinement unavoidable for high resolution real time global NWP
  - I/O performance and scaling (esp. ensembles)
  - Coupling – overhead from coupling itself and from "least scalable component"

- Technical emphases for HPC readiness in NGGPS
  - HPC architectures with lowest overhead/highest reward path to operations
  - Standard, mature, widely adopted programming models
  - Monitor developments in other technologies and approaches, resources and schedules permitting.

Relationships to Other Projects

NUOPC Physics component and and physics interface

HIWPP Model evaluation and HPC readiness (OAR)

SENA Software Engineering for Novel Architectures (NOAA HPCC)

CIME Common Infrastructure for Modeling the Earth (NSF/DOE)

ESPC/AOLI Air-Ocean-Land-ICE Global Coupled Prediction Project

OAS Team NGGPS Overarching System Team (Cecelia)

Nesting NGGPS Nesting and mesh refinement team (Vijay)

GAPS

- How to align and coordinate effort and activity currently in the model groups and EMC with NGGPS objectives, schedules?

    – How are responsibilities divided? What activities are most appropriately left within the modeling groups and which need to be brought into and performed by NWS?

    – How and to what extent can processes be unified or at least made complementary?

    – How are requirements collected and prioritized? Conflicting requirements?

- Roles

    – What is SAE Team? A planning and advisory group or more hands on?

    – What is relationship to existing groups: modeling groups, DTC and EMC?

- Are NGGPS software and engineering efforts effectively structured and in a position to learn from and adapt as necessary to successes and lessons learned from other community modeling efforts?

Proposed Next Steps

- Before end of FY15:
  - Clarification of objectives and role for SAE Team (end of FY15)
  - Finalize membership
  - Kick-off meeting
- Before end of Q1 FY 16:
  - Implementable work plans with objectives, scope, resources, stakeholders and partnerships
    - Tasks related to NGGPS Phase-II testing (
    - Tasks related to enhanced software processes and practices
    - Tasks related to community support
    - Tasks related to HPC readiness
    - **Every task starts with gathering, analysis and specification of requirements**
  - Every work plan specifies delivery schedule with *substantive* end of FY16 deliverables (except Phase-II testing which will be finished at end of Q3 FY16, here Phase-II planning will be included)