Software Architecture and Engineering

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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
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¹ NOAA National Centers for Environmental Prediction
² NOAA Geophysical Fluid Dynamics Laboratory
³ National Center for Atmospheric Research
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.dtccenter.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)
  
- 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

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
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<tbody>
<tr>
<td>NUOPC</td>
<td>Physics component and and physics interface</td>
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<tr>
<td>HIWPP</td>
<td>Model evaluation and HPC readiness (OAR)</td>
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<td>SENA</td>
<td>Software Engineering for Novel Architectures (NOAA HPCC)</td>
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<td>CIME</td>
<td>Common Infrastructure for Modeling the Earth (NSF/DOE)</td>
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<td>ESPC/AOLI</td>
<td>Air-Ocean-Land-ICE Global Coupled Prediction Project</td>
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<td>OAS Team</td>
<td>NGGPS Overarching System Team (Cecelia)</td>
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<td>Nesting</td>
<td>NGGPS Nesting and mesh refinement team (Vijay)</td>
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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)