Date: 7/28/2020

To: James Ahrens

cc: David Pugmire, David Rogers, Hank Childs, Berk Geveci

From: Kenneth Moreland, WBS 2.3.4.13 / ECP/VTK-m

Milestone Deliverable - STDA05-53

Milestone Due Date: July 31, 2020

Milestone Completion Date: July 20, 2020

Description of Milestone:
The STDA05-53 milestone comprises the following tasks.

- Implement device adapters that use the Kokkos library.
- Continue implementation of data model and analysis and visualization to support WDM.
- Engage with another ECP application to determine needs for flow analysis and visualization and implement a prototype.
- Enhancements to VTK-m for VisIt.
- Update vtkm tests to use data files for testing.
- Deploy advanced flow technique to ECP Application
- Prototype implementation of filters supporting higher order data models. This prototype implementation will not take advantage of higher order information, but will ensure that that filters still operate on this data, treating it as standard linear elements.
- Draft initial design to support data on multiple devices simultaneously.
- Implement Performance Regression Testing Infrastructure.
- Collaborate with ALPINE team members to implement algorithms requiring these capabilities.
- Work with our stakeholders to determine what they need from VTK-m Spack package, and update the VTK-m Spack package in response to those needs.
- Initial design for deprecation mechanism.
- Complete VTK-m image rendering/comparison testing framework and update tests as appropriate.
- Level of effort VTK-m maintenance activities.
- Miscellaneous outreach activities.

Completion Proof of the Milestone:
Each task represents development in the VTK-m library. The lifespan of a development meta-task (spanning multiple P6 Activities) involves, where applicable, a design, implementation, and documentation. The design is captured using the GitLab issue tracker associated with the VTK-m code repository. The development is captured in GitLab merge requests, which are an artifact of

the development workflow within the VTK-m software. Documentation usually includes contributions to the *VTK-m User's Guide*. Artifacts that do not fall into any of these catagories are listed as links under "External Artifacts."

The following list provides evidence for each task in the form of GitLab issues, GitLab merge requests, and documentation.

- Kokkos Device Adapters
  - Design
    - Implement Kokkos based device adapter backend (#485)
  - Merge Requests
    - Add Kokkos backend (!2164)
  - Documentation
    - Add Kokkos device adapter (!86)
  - External Artifacts
    - https://gitlab.kitware.com/vtk/vtk-m-user-guide
- Visualization for WDM application
  - Design
    - Visualization for WDM application (#469)
  - External Artifacts
    - https://github.com/m-kim/Puma
    - https://github.com/m-kim/Puma/blob/master/README.md
    - https://github.com/m-kim/Puma/commit/e819767cad51a66829877448fd3dfed07a25fc91
    - https://github.com/m-kim/Puma/commit/bb8808cf175a548dd324934d4fb4bc49af53039d
    - https://github.com/m-kim/Puma/commit/a44236270695c9a9da3142ed5957ad375ed727fd
    - https://github.com/m-kim/Puma/commit/ff06b4d9e16ba29941ca9c041cfa130fa99fc112
    - https://github.com/m-kim/Puma/commit/62845f6de2e911743b13be70f6351b5a79e423ad
    - https://github.com/m-kim/Puma/commit/c32066c0fa72aee6c42cd82390f7727ce77e29ed
    - https://github.com/m-kim/Puma/commit/7279ef7f567170655a4f6739a500757128883dbd
    - https://github.com/m-kim/Puma/commit/b83596563c6383f66db20cc5f8fbf526eb6701f1
    - https://github.com/m-kim/Puma/commit/ec0bf9b33c9ce785e7572d9370069adee53a3ad5
    - https://github.com/m-kim/Puma/commit/4ae2f1df2c3e156fb06caf591525a4a9c5023628
    - https://github.com/m-kim/Puma/commit/5ec3c017603391e213295dda33a32794d260a166
    - https://github.com/m-kim/Puma/commit/ea9f0d2e0c87d9bbf7d49b5198f73ce494cf7ae6

- o https://github.com/m-kim/Puma/commit/a21fd196829d25eba59582ffe860360450e20d38
- o https://github.com/m-kim/Puma/commit/36e04b483fdbcea93d2d096abad237814d3cddf4
- o https://github.com/m-kim/Puma/commit/8cd7c25b9408f6adf9897c1b0f6eb098e6175a9a
- Advanced Flow Techniques (ORNL)
  - Design
    - o Particle Advection Enhancements (#472)
    - o Design for Advanced Flow Visualization for WarpX (#549)
  - Merge Requests
    - o Fix TemporalAdvection example by removing call to .Set on a ReadPortal(). (!2071)
    - o Add particle advection filter. (!2152)
- Deployment in VisIt
  - Design
    - o VTK-m support in VisIt (#468)
- Data files for tests
  - Design
    - o Update Unit Test Infrastructure to Use Data Files Stored in Git LFS (#462)
  - Merge Requests
    - o Encode pngs (!2048)
    - o Build vtkm_io library and associated refactoring (!2063)
    - o Deprecate io/writer/ directory (!2065)
    - o Deprecate io/reader directory (!2067)
    - o Add uniform dataset to data dir. (!2079)
    - o ReadPortal().Get(idx) is slow in a loop; attempt 2 (!2078)
    - o Test BOV reader. Fix slow WritePortal().Set(idx, val) loop. (!2081)
    - o Mark pixel destructors as virtual to fix build error. (!2091)
    - o Deprecate ReadPortal().Get pattern. (!2085)
    - o Remove overly verbose log print. (!2097)
    - o Deprecate DataSetFieldAdd. (!2106)
    - o Fix C++17 build. (!2121)
    - o Update demo to exhibit more VTK-m capabilities. (!2134)
    - o Demangle symbols in PrintSummary. (!2137)
    - o Remove Initialize() boilerplate. (!2127)
    - o Silence spurious gcc-10 warning. (!2135)
    - o Deprecate Camera::Activate() and Camera::Finish() (!2139)
    - o Deprecate StartScene() and EndScene() (!2140)
    - o Float distance, attempt 2 (!2160)
- Advanced Flow Techniques (UO)
  - Merge Requests
    - o Fix order of initialized seeds to match output format (!2084)
    - o Updating Euler Integrator to work (!2023)
    - o Generalize flow field representation (!2019)

- Higher order mesh support
  - Design
    - Report for "Higher order mesh support:1 Design" (#470)
  - External Artifacts
    - vtkm_hoe_3_report_V3.pdf
- ArrayHandle thread safety
  - Design
    - Implement thread safety in ArrayHandle (#435)
    - Order asynchronous ArrayHandle access (#491)
    - Early enqueuing of Tokens in ArrayHandle (#492)
  - Merge Requests
    - Add proper enqueuing of Tokens for ArrayHandle (!2130)
    - ArrayHandleMultiplexer fixes (!2133)
    - Add common superclass to VariantArrayHandleBase (!2142)
  - Documentation
    - Token (!57)
- Resampling/Statistics/Random Numbers
  - Design
    - Random Number Generator (#461)
  - Merge Requests
    - United We Stand (!2128)
    - ArrayHandleRandomUniformReal (!2116)
    - Statistics based testing for ArrayHandleRandomUniformReal (!2148)
    - Add ArrayHandleRandomStandardNormal (!2150)
- Deployment in Spack
  - External Artifacts
    - https://github.com/spack/spack/blob/develop/var/spack/repos/builtin/packages/vtk-m/package.py
    - https://github.com/spack/spack/pull/16192.
- Test image comparison
  - Design
    - Implement Test Image Comparison (#437)
  - Merge Requests
    - Regression Testing Images (!2161)
    - Improvements to git-lfs test (!2022)
    - Make a vtkm lib for lodepng (!2034)
    - incorporate -fPIC flag in lodepng when buliding linux (!2060)
    - Image IO Library (!1967)
    - Move VTK file readers and writers into vtkm_io (!2100)
    - Image reader and writer structure (!2109)
  - Documentation
    - Implement filter docs for image testing (!85)
- VTK-m Maintenance (Kitware)
  - Merge Requests
    - Convert more builders (!2016)
    - vtkm_option should be used as it properly handles CMP0077 (!2020)

- o [removed doxygen warning at ArrayHandleRandomUniformBits](#) (!2025)
- o [Lfs setup fixups](#) (!2026)
- o [contour_tree_augmented example compiles when TBB is enabled](#) (!2024)
- o [Add scripts to allow developers to replicate CI environments](#) (!2030)
- o [Update gitlab-ci to use a version of sccache that supports CUDA](#) (!2033)
- o [Revert "Update gitlab-ci to use a version of sccache that supports CUDA"](#) (!2038)
- o [Update cmake minimum required version to 3.12](#) (!2037)
- o [Using auto in WorkletInvokeFunctorDetail](#) (!2035)
- o [Flying Edges now works with multiple contours](#) (!2039)
- o [gitlab ci tests jobs now timeout after 50min](#) (!2043)
- o [Update gitlab-ci to use a version of sccache that supports CUDA](#) (!2044)
- o [Correct ubuntu1604 gcc48 test failures](#) (!2042)
- o [Restrict the OpenMP threads # gitlab-ci tests uses](#) (!2046)
- o [FindTBB: synchronize with VTK](#) (!2049)
- o [MeshQuality and Cell metrics use vtkm::ErrorCode](#) (!2041)
- o [make ubuntu1804_gcc6 run for each merge request and not just nightly](#) (!2050)
- o [Add an asan to our gitlab ci suite](#) (!2051)
- o [fixes OMP reduction when using OMP_NUM_THREADS lt 4](#) (!2053)
- o [generalize ThreadIndicesType across multiple worklets fetchs](#) (!2032)
- o [Make sure merge request ci builds examples](#) (!2069)
- o [removed rendering classes related to OpenGL/OSMESA/EGL](#) (!2010)
- o [Dataset::AddField replaces existing fields with the same name](#) (!2058)
- o [Add windows shell ci worker](#) (!2055)
- o [Fix Dashboard warnings](#) (!2082)
- o [ThreadIndicesTopologyMap optimization when MaskNone and ScatterIdentity used](#) (!2027)
- o [Log CDash build ids from each step of the build process](#) (!2090)
- o [Presume NVCC has zero support for VTK_M_DEPRECATED_ATTRIBUTE_SUPPORTED](#) (!2088)
- o [Update sccache to latest master which now has full nvcc support](#) (!2096)
- o [filter::ImageMedian can be used in multiple compilation units](#) (!2102)
- o [docs: update gitlab links to include /-/ component](#) (!2104)
- o [Improve flying edge perf](#) (!2080)
- o [gitlab-ci test jobs better handle false positive failures](#) (!2098)
- o [vtkm::io::reader::BOVDataSet fix 'constructor delegates to itself'](#) (!2107)
- o [Remove CMake workarounds for version < 3.12](#) (!2110)
- o [Update ci](#) (!2114)
- o [Gitlab ci automatically update doxygen on merge to master](#) (!2117)
- o [Build Diy as a Library](#) (!1963)
- o [Correct flying edge cell-id mapping](#) (!2124)
- o [Build diy as a library](#) (!2123)
- o [Correct bug(s) in FlyingEdges found by demo example](#) (!2125)
- o [Gitlab-ci no has builds without rendering enabled](#) (!2120)
- o [Make sure we don't leak our findmpi module](#) (!2153)

- o Remove some unneeded include statements from vtkm/exec (!2156)
- o Remove New Mexico Consortium CI as hardware has been removed (!2158)
- VTK-m Maintenance (SNL)
  - Merge Requests
    - o Fix unused parameter warnings (!2017)
    - o [CUDA doesn't like [[deprecated]] when applied to typedefs](https://gitlab.kitware.com/vtk/vtk-m/merge_requests/2018) (!2018)
    - o Fix scan-by-key with a fancy output array (!2045)
    - o Fix reduce-by-key with a fancy output array (!2047)
    - o Restore device tests (!2054)
    - o Fix compile error in UnitTestTaskStrided.cu from changes in Fetch (!2062)
    - o Have filter specify its own field types (!2064)
    - o Example fixes (!2074)
    - o Fix conversion warnings in benchmarks and examples (!2092)
    - o Update changelogs (!2099)
    - o Deprecate Execute with policy (!2093)
    - o Precompiled field map permutation and averaging (!1954)
    - o Add dashboard using VTK types (!2103)
    - o Fix an issue with structured (non-uniform) gradients (!2118)
    - o Non tested fixes (!2119)
    - o Enable setting invalid value in probe filter (!2122)
    - o Fix warnings about overriding deprecated methods (!2151)
    - o Disable asserts for cuda architecture builds (!2157)
    - o Make tests that throw an STL exception fail (!2159)
    - o Fix warnings about data type conversion (!2146)
    - o Change CI script hash-bang from /bin/env to /usr/bin/env (!2163)