APP + Trilinos Integration

Status, Opportunities, and Challenges

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Current Status of APP + Trilinos Integration

- Charon + Trilinos Integration:
  - ASC FY07 Vertical Integration Milestone
  - Automated daily integration testing done against Trilinos 7.0, 8.0, and Dev
  - Charon could not upgrade to Trilinos 8.0 last year because Xyce did not upgrade
  - Charon will release against Trilinos 7.0 later this quarter!
  - John Shadid is building and running Charon against recent snapshots of Trilinos Dev
  - Charon was not tested against Trilinos 9.0 and there is no interest from the semi-conductor side
  - What about Xyce + Charon + Trilinos integration?
  - Conclusion: Current Trilinos release process has little impact on Charon

- Xyce + Trilinos Integration:
  - Ad-hoc manual integrations with Xyce + Trilinos Dev was done prior to branch of Trilinos Release
  - Testing of Xyce + Trilinos 9.0 brach was *not* done => Xyce can not build against Trilinos 9.0 and it has consumed several weeks worth of effort!

Current Status of APP + Trilinos Integration

- Alegra + Trilinos Integration:
  - Automated testing of Alegra + Trilinos Dev was conducted before Trilinos 9.0 branch ... Several problems were resolved before Trilinos 9.0 was branched!
  - Alegra switched over to Trilinos 9.0 after branch (but stopped testing against Trilinos Dev)
  - New Xyce TPL depends on Trilinos with versioning issues
  - Alegra was ready to switch to Trilinos 9.0 by 10/15 but could not because Xyce does not build against Trilinos 9.0!
  - Alegra would like to do a Alegra + Xyce + Trilinos Dev daily integration to support their work!

- Aleph + Trilinos Integration:
  - They take snapshot of Trilinos Dev from time to time and build against that
  - Automated testing of Aleph against Trilinos Dev Shapshot
  - Aleph would be very interested to use the STK IO capabilitily that might be moved into Trilinos?
  - In this case, they would be very interested in doing daily integration with Trilinos Dev ...

Current Status of APP + Trilinos Integration

- Titan/VTK + Trilinos Integration:
  - They currently do informal builds against snapshots of Trilinos Dev
  - They have already experienced a regression between updated snapshots
  - They want to move to automated daily integration testing with Trilinos Dev

- SIERRA + Trilinos Integration:
  - Driven by Algorithm Integration Project
    - Embedded algorithms in SIERRA
  - SIERRA does *not* use the Trilinos build system, they build Trilinos with BJAM
  - Developer environment built constructed with Python scripts (STANA scripts)
  - Daily integration testing for all of SIERRA + Trilinos Release and Dev
  - Continuous Integration testing done every two hours for Aria + Trilinos Release and Dev
  - Extensive testing and porting before the branch of Trilinos 9.0
  - Upgrade to Trilinos 9.0 went very smoothly
    - Transition to Trilinos 9.0 was done in less than one week (could have been done in one day)

SIERRA + Trilinos Integration: STANA Website

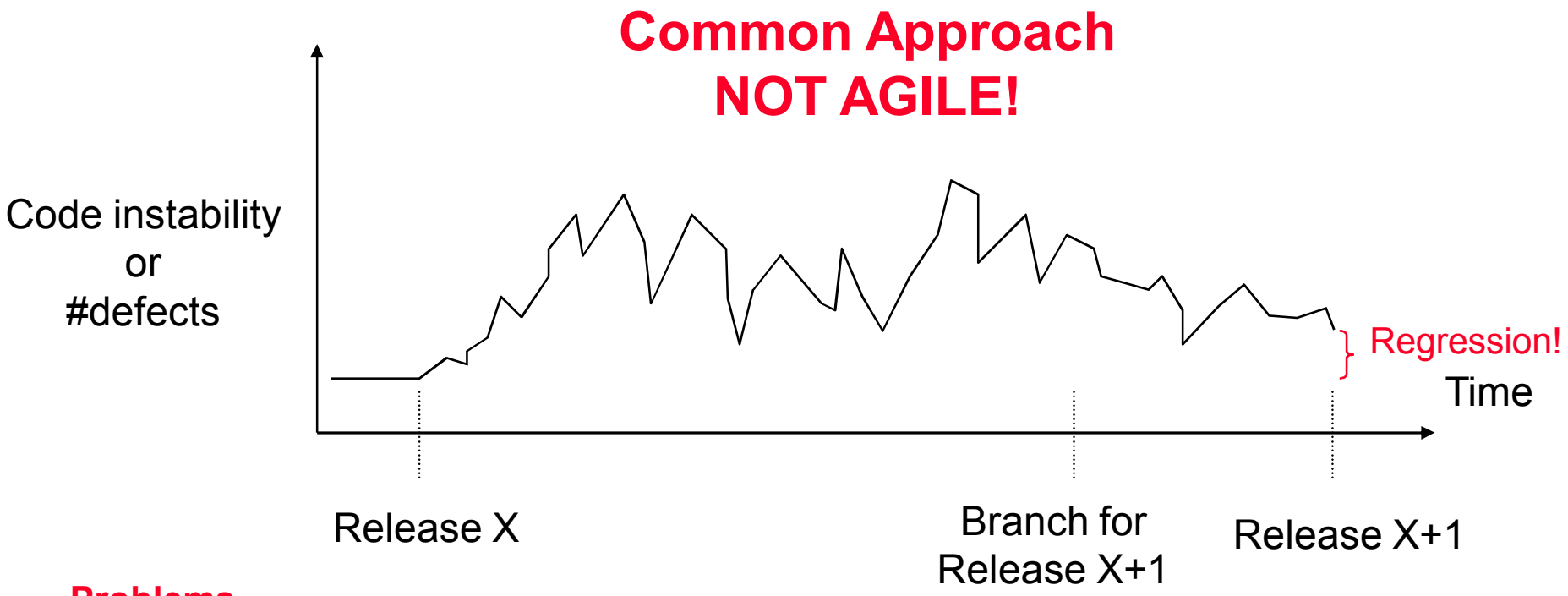
http://sierra-trac.sandia.gov/trac/sierra/wiki/Modules/Aria/SubProjects/STANA

Lean/Agile Software Engineering Principles

- High quality software is developed in small increments and with sufficient testing in between sets of changes.
- High quality defect-free software is most effectively developed by not putting defects into the software in the first place (i.e. code reviews, pair programming etc.).
- High quality software is developed in short fixed-time iterations.
- Software should be delivered to real (or as real as we can make them) customers is short intervals.
- Ruthlessly remove duplication in all areas.
- Avoid points of synchronization. Allow people to work as independently as possible and have the system set up to automatically support this.
- Most mistakes that people make are due to a faulty process/system (W. Edwards Deming).
- Automation is needed to avoid mistakes and improve software quality.

References: http://www.cs.sandia.gov/~rabartl/readingList.html

Lean/Agile Methods: Development Stability

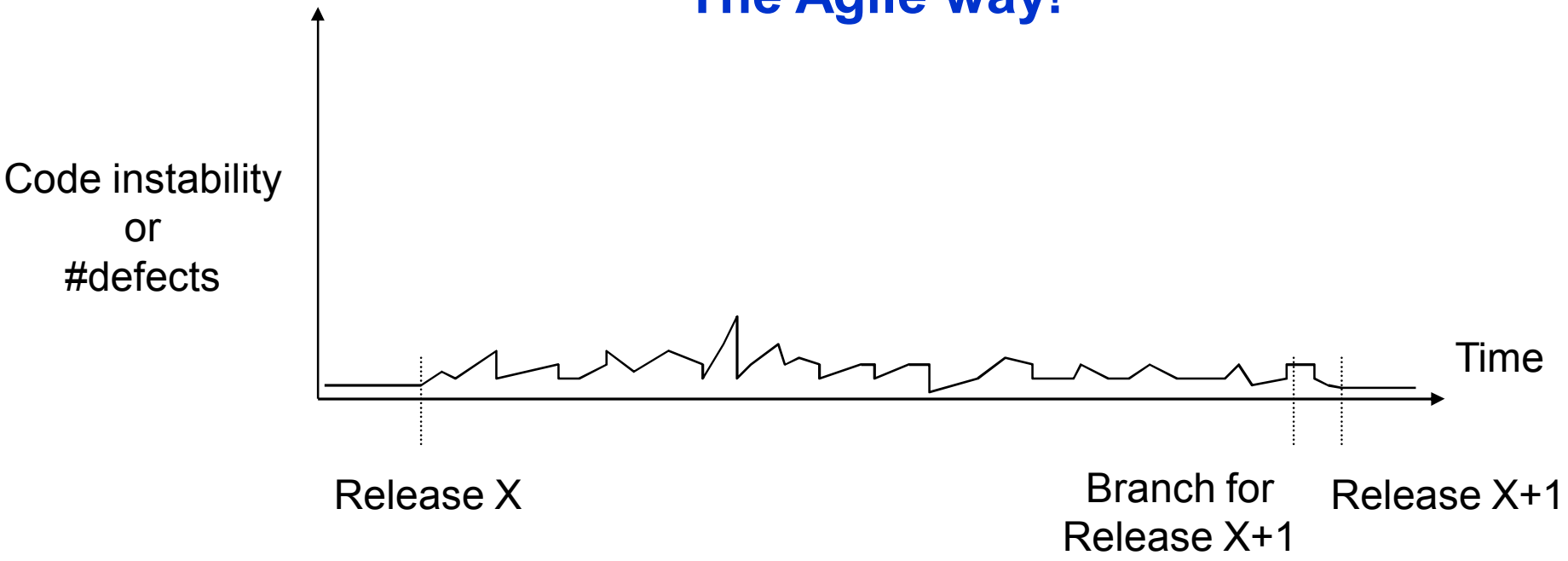


Problems

- Cost of fixing defects increases the longer they exist in the code
- Difficult to sustain development productivity
- Broken code begets broken code (i.e. broken window phenomenon)
- Long time between branch and release
  - Difficult to merge changes back into main development branch
  - Temptation to add “features” to the release branch before a release
- High risk of creating a regression

Lean/Agile Methods: Development Stability

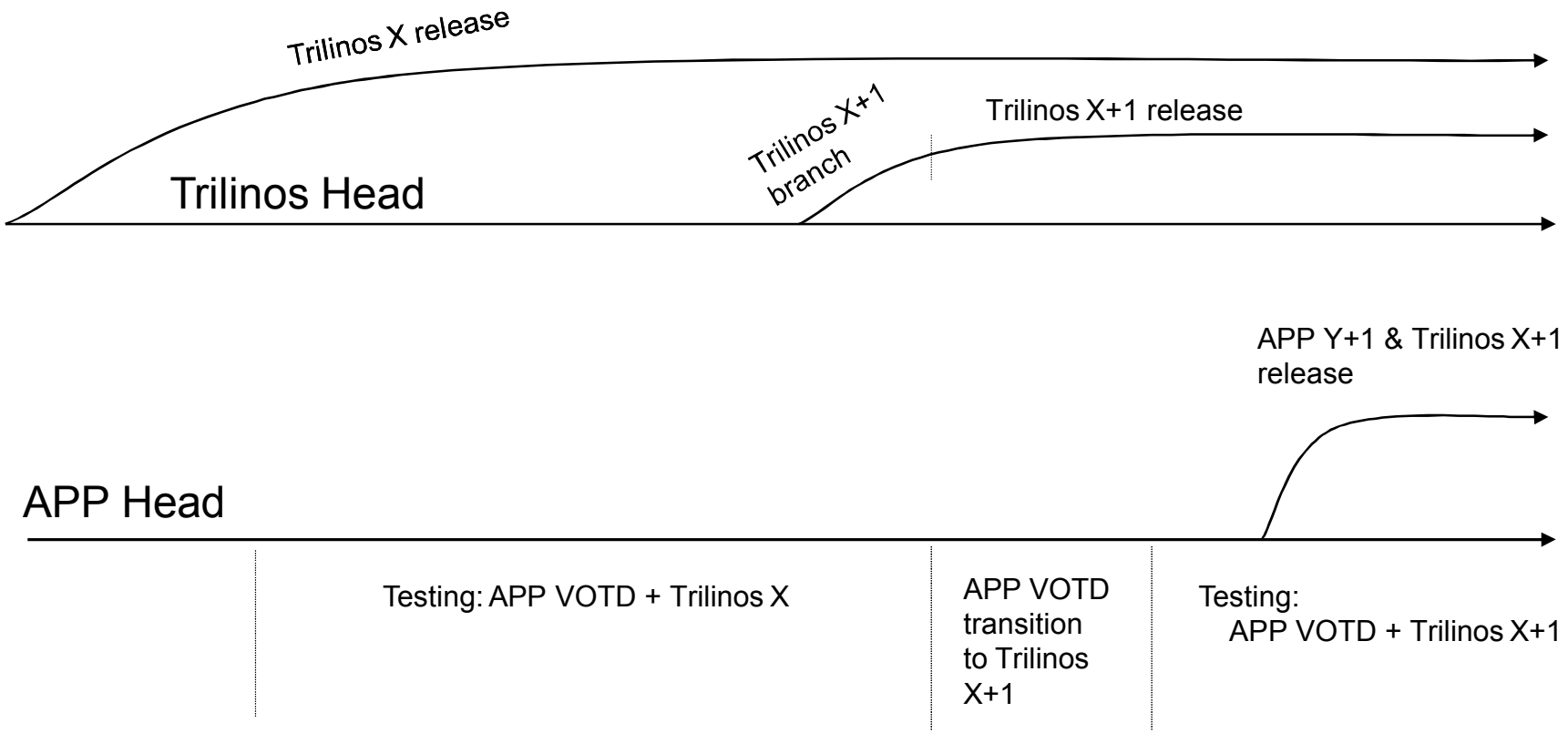
The Agile way!



Advantages

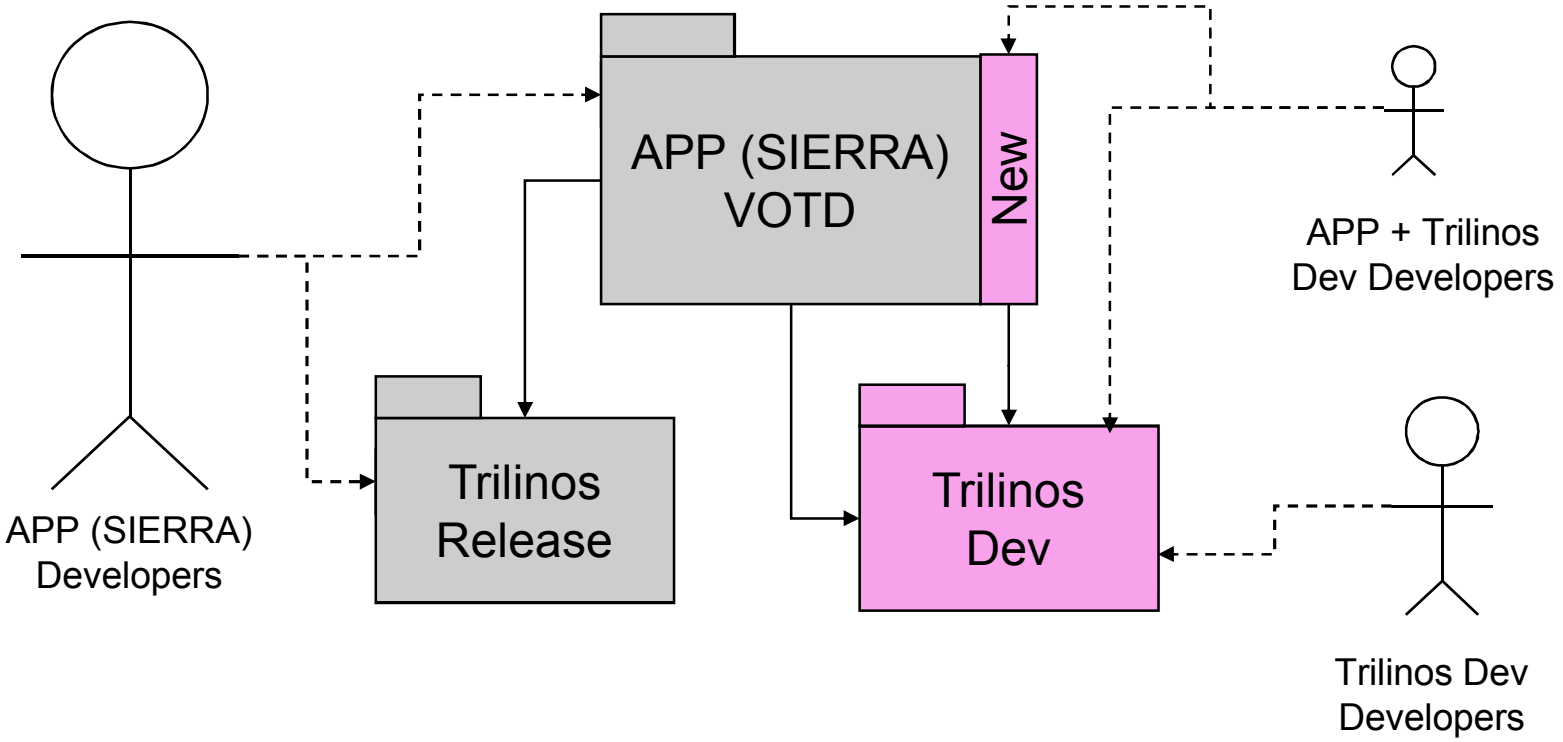
- Defects are kept out of the code in the first place
- Code is kept in a near releasable state at all times
- Shorten time needed to put out a release
- Allow for more frequent releases
- Reduce risk of creating regressions
- Decrease overall development cost

APP Only Upgrades After Each Major Release of Trilinos



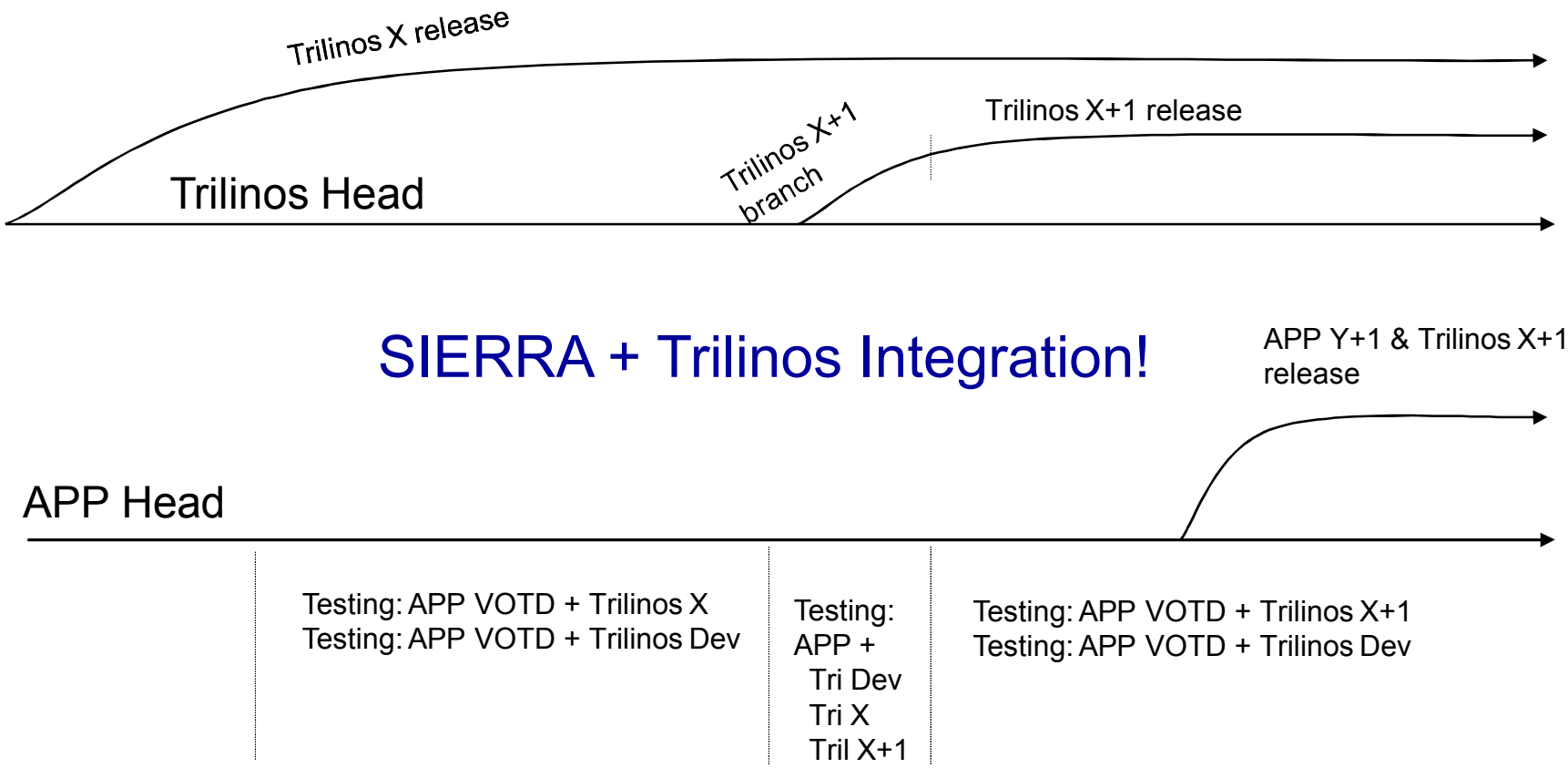
- Transition from Trilinos X to Trilinos X+1 can be difficult and open ended
- Large batches of changes between integrations
- Greater risk of experiencing real regressions
- Upgrades may need to be completely abandoned in extreme cases

APP Builds Against both Trilinos Release and Trilinos Dev



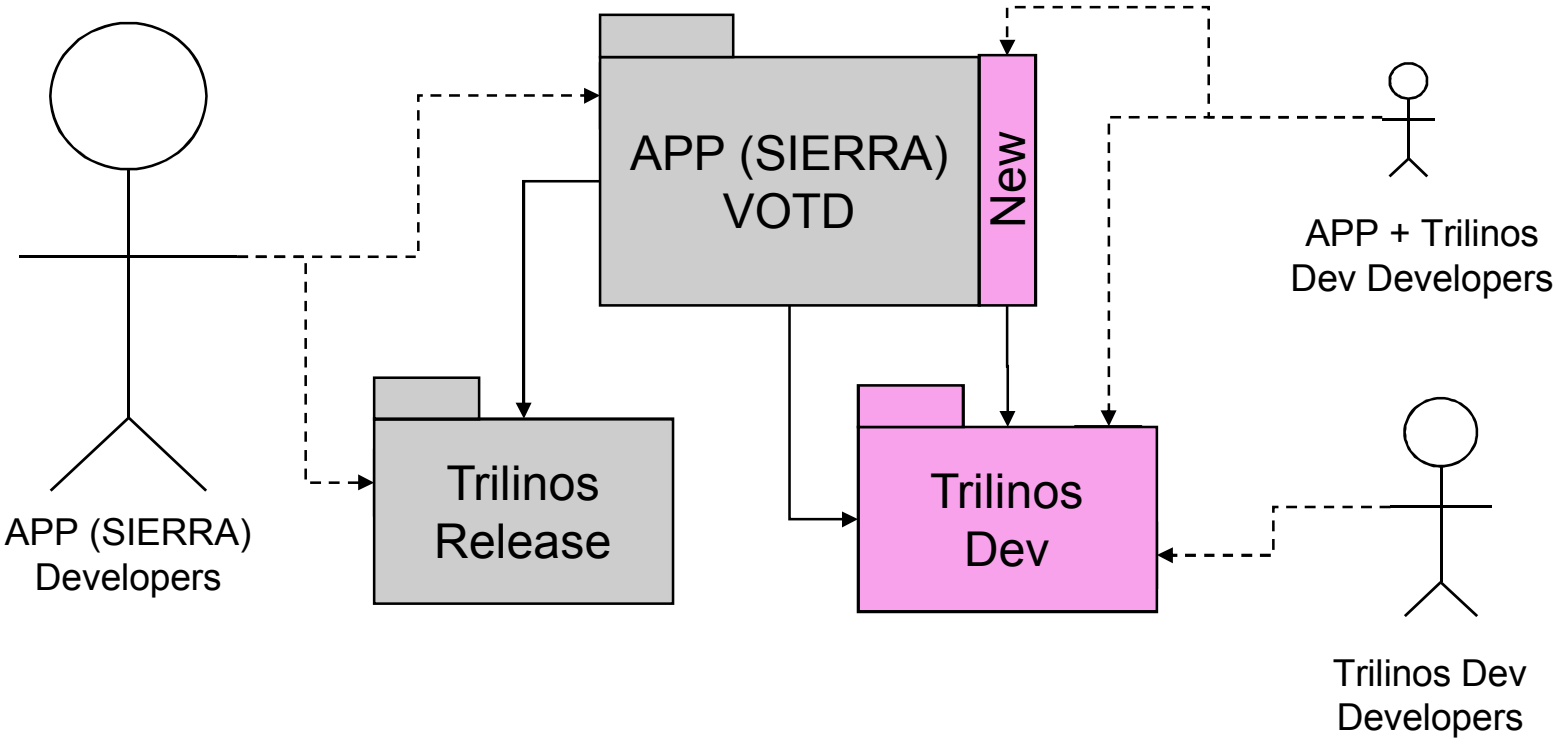
- APP (SIERRA) VOTD Developers only build/test against Trilinos Release
- Changes between Trilinos Release and Trilinos Dev handed through:
  - Refactoring
  - Minimal ifdefs (NO BRANCHES)!
- Trilinos Dev Developers work independent from APP
- Use of staggered releases of Trilinos and APP
- APP + Trilinos Dev Developers drive new capabilities

APP Builds Against both Trilinos Release and Trilinos Dev



- All changes are tested in small batches
- Low probability of experiencing a regression
- Extra computing resources to test against 2 (3) versions of Trilinos
- Some difficulty flagging regressions of APP + Trilinos Dev
- APP developers often break APP + Trilinos Dev
- Difficult for APP to have rely on Trilinos too much
- Hard to verify Trilinos for APP before APP release

Challenges of APP + Trilinos Release and Dev Integration



Problems

- APP developers sometimes break APP + Trilinos Dev New
- APP + Trilinos Dev inherits instability of APP and Trilinos development lines

Improvements

- Make Trilinos Dev backward compatible with Trilinos Release
  - => Minimize need to refactor and ifdef
- Improve stability of Trilinos Dev
- Improve stability of APP VOTD

SIERRA + Trilinos Integration: Opportunities and Challenges

- SIERRA Framework Developers would like to consider tighter integration with Trilinos:
  - Move new SIERRA toolkits packages into Trilinos
    - STK_Mesh
    - STK_IO?

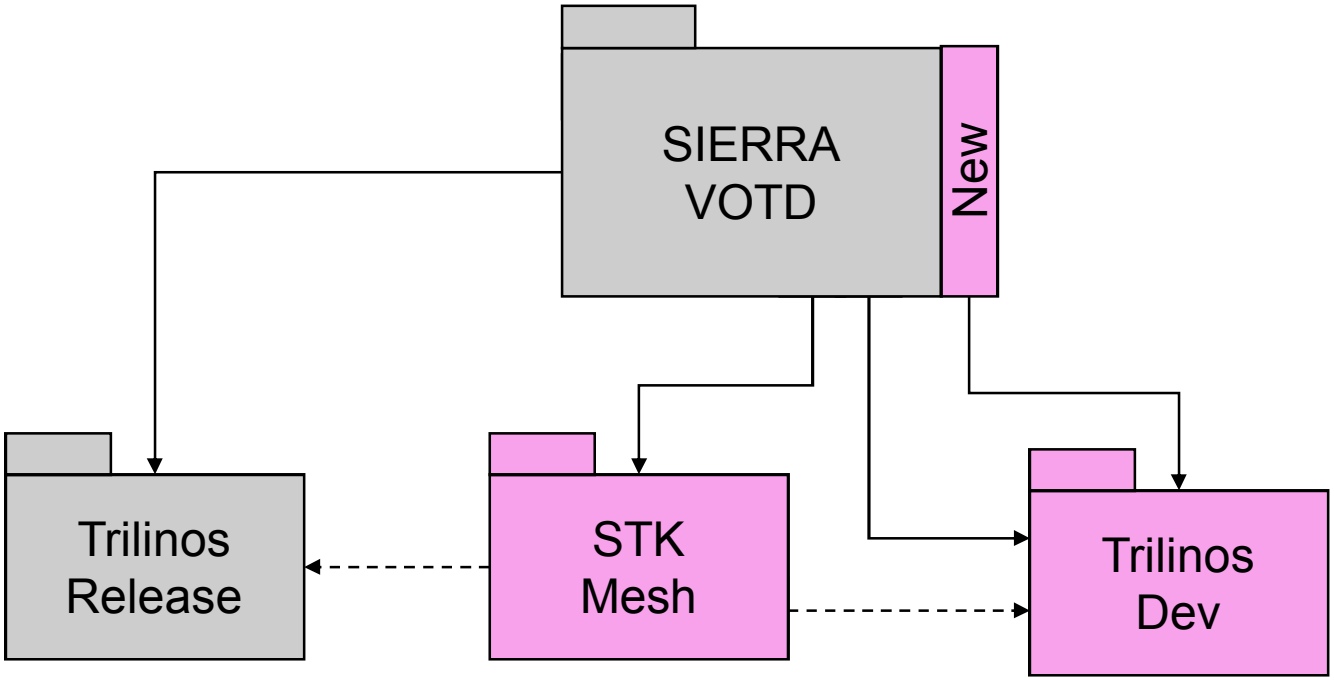
    => Make these available for rapid production and other projects
  - Develop the FEI through Trilinos instead of a SIERRA TPL

    => Allow FEI to be updated more frequently
  - Replace SIERRA code with Trilinos code:
    - Teuchos::ParameterList
    - Intrepid
    - Phalanx

    => Reduce duplication and increase Trilinos impact

- Challenge: Tighter integration of APP and Trilinos does not fit well into current APP + Trilinos Release and Dev model!

APP + Trilinos Integration: Problems with Tighter Integration



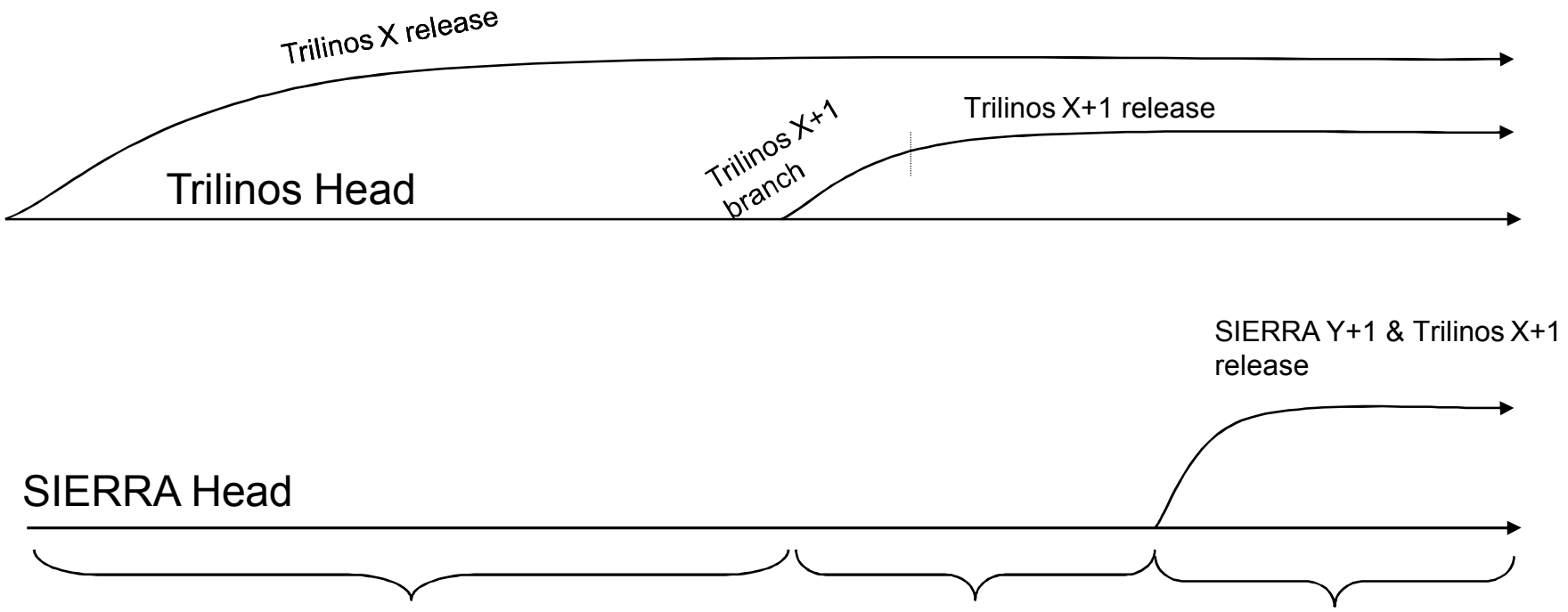
Approach?

- Check out STK Mesh from Trilinos separately to build with SIERRA?
- Ifdef STK Mesh to build against both Trilinos Release and Trilinos Dev?

Problems

- Development of STK Mesh requires new features in Trilinos packages (i.e. Teuchos)
- STK Mesh built against Trilinos Release will not have some features!

APP + Trilinos Integration: Problems with Tighter Integration



Activity: Develop new features of STK Mesh (new) with new Trilinos Dev features

Test: SIERRA + STK Mesh + Trilinos Release
Test: SIERRA + STK Mesh (new) + Trilinos Dev

Any new development of STK Mesh (new) against Trilinos Dev will not impact release SIERRA Y+1!

Activity: Develop new features of STK Mesh (new) with new Trilinos Dev features

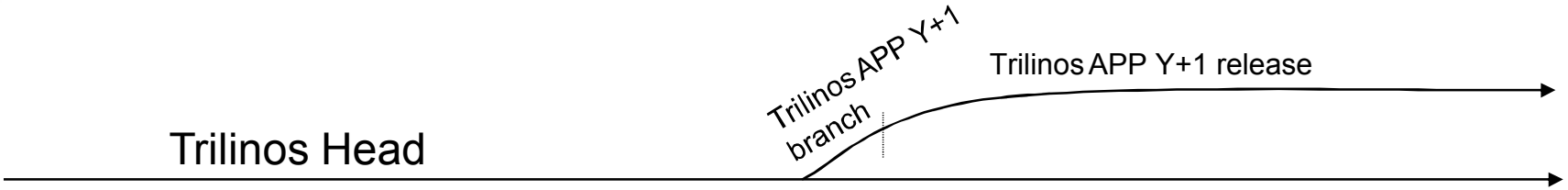
Conclusion: This will be complex and may involve risk!

Is there another way?

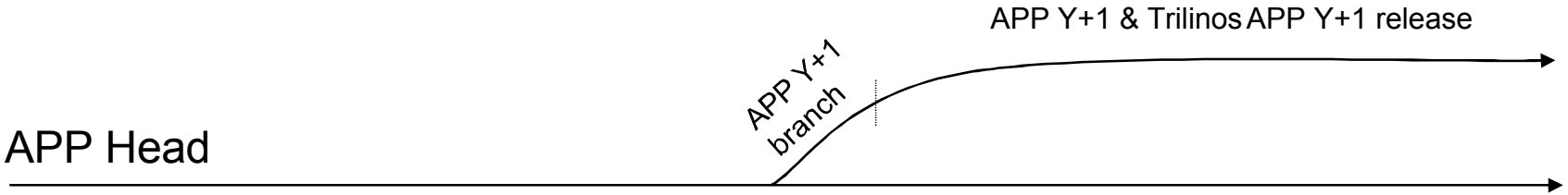
APP + Trilinos Integration: Different Collaboration Models

- APP only upgrades after each major release of Trilinos
  - Little to no testing of APP + Trilinos Dev in between versions
- APP builds against both Trilinos Release and Trilinos Dev
  - APP developers work against Trilinos Release
  - APP + Trilinos team(s) build against Trilinos Dev
  - Nightly and continuous integration testing done for both APP + Trilinos Release and Dev
  - Must handled staggered releases of Trilinos and APP
- APP developed only against Trilinos Dev
  - APP developers work directly against Trilinos Dev checked out every day
  - Releases best handled as combined releases of APP and Trilinos

APP developed only against Trilinos Dev



Future of SIERRA + Trilinos Integration?

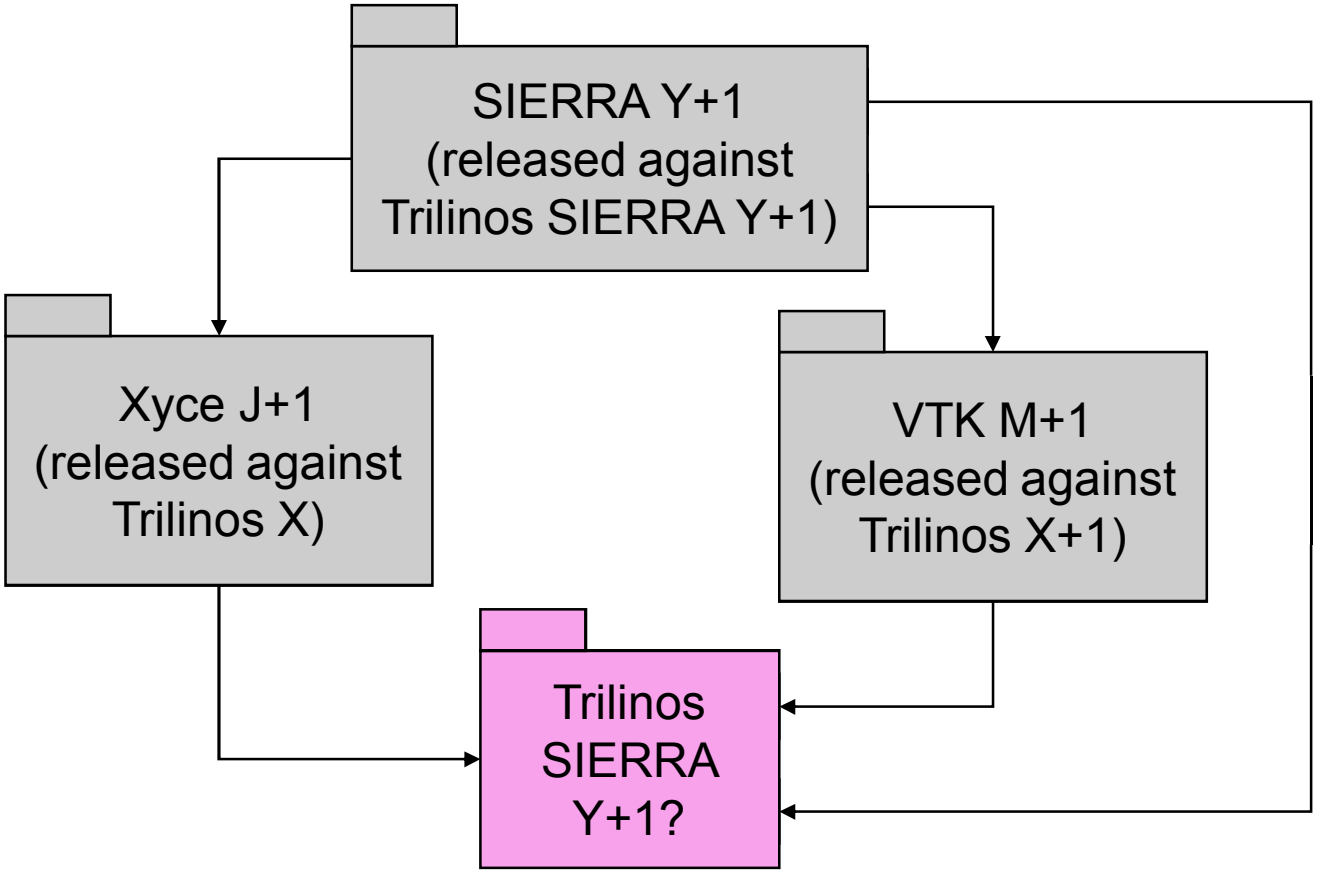


Testing: APP VOTD + Trilinos Dev

Supported with continuous integration testing!

- All changes are tested in small batches
- Low probability of experiencing a regression
- Less computing resources for testing
- Regressions and flagged immediately by APP developers
- Can support tighter integration efforts
- Supports rapid development of new capability from top to bottom
- Requires Trilinos to be more stable
- Other issues arise as well

Challenges with APP-Specific Trilinos Releases



Multiple releases of Trilinos presents a possible problem with complex applications

Solution:

=> Provide perfect backward compatiblity of Trilinos X through Trilinos SIERRA Y+1

APP + Trilinos Continuous Integration: Solutions

- Proposed appraoch:
  - Develop APP VOTD directly against Trilinos Dev (not against Trilinos Release)
  - Create special releases of Trilinos just for these APPs
  - APP-specific releases only needed for these special APPs where tighter integration is needed
  - Protect development work with continuous integration server and feedback

- Improvements to Trilinos needed to support this:
  - Improve the stability “Stable” code in Trilinos Dev (see later presentation)
  - Preserve perfect backward compatibility for Trilinos for some period of time
    => Allows some flexibility of what version of Trilinos gets used
  - Improve other related software engineering practices

See the talk:

“Maintaining stability of Trilinos Dev - Stable vs Experimental Code”