



Git Workflows

ATPESC 2019

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July 28 – August 9, 2019

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- Requested citation: Jared O’Neal, Git Workflows, in Better Scientific Software Tutorial, Argonne Training Program on Extreme-Scale Computing (ATPESC), St. Charles, IL, 2019. DOI: [10.6084/m9.figshare.9272813](https://doi.org/10.6084/m9.figshare.9272813).

Acknowledgements

- This work was supported by the U.S. Department of Energy Office of Science, Office of Advanced Scientific Computing Research (ASCR), and by the Exascale Computing Project (17-SC-20-SC), a collaborative effort of the U.S. Department of Energy Office of Science and the National Nuclear Security Administration.
- This work was performed in part at the Argonne National Laboratory, which is managed by UChicago Argonne, LLC for the U.S. Department of Energy under Contract No. DE-AC02-06CH11357
- Anshu Dubey, Klaus Weide, Saurabh Chawdhary, and Carlo Graziani
- Iulian Grindeanu

Goals

Development teams would like to use version control to collaborate productively and ensure correct code

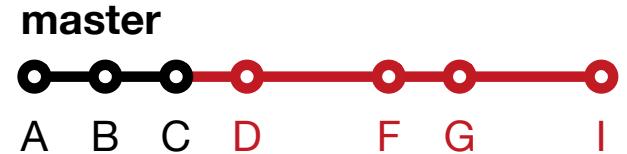
- Understand challenges related to parallel code development *via* distributed version control
- Understand extra dimensions of distributed version control & how to use them
 - Local vs. remote repositories
 - Branches
 - Issues, Pull Requests, & Code Reviews (Previous talk)
- Exposure to workflows of different complexity
- What to think about when evaluating different workflows
- Motivate continuous integration

Distributed Version Control System (DVCS)

Two developers collaborating *via* Git

- Local copies of master branch synched to origin
- Each develops on **local** copy of master branch
- All copies of master immediately diverge
- How to **integrate** work on origin?

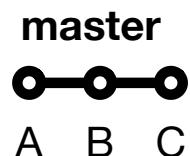
Alice's Local Repository



Bob's Local Repository



Main Remote Repository (origin)



● = commit
X = commit ID

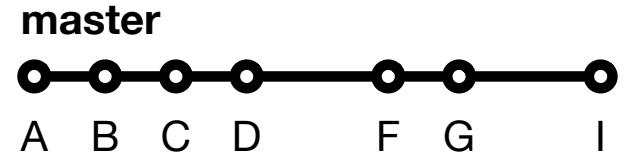
— = branch

DVCS Race Condition

Integration of independent work occurs when local repos interact with remote repo

- Alice pushes her local commits to remote repo first
- No integration conflicts
- No risk
- Alice's local repo identical to remote repo

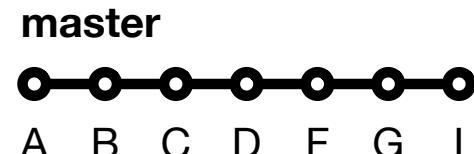
Alice's Local Repository



Bob's Local Repository



Main Remote Repository (origin)



● = commit
X = commit ID

Integration Conflicts Happen

Bob's push to remote repo is rejected

- Alice updated code in commit D
- Bob updated same code in commit E
- Alice and Bob need to study conflict and decide on resolution at pull (time-consuming)
- Possibility of introducing bug on master branch (risky)

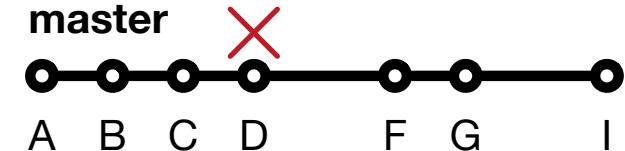
loops.cpp (commit C)

```
36
37 // TODO: Code very important loop here ASAP
38
39
40 ...
41
42 // TODO: Code other very important loop here ASAP
43
44
```

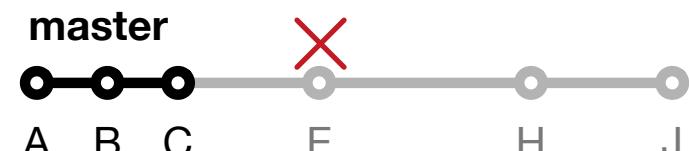
loops.cpp (commit D)

```
36
37 // Very important loop
38 for (int i=0; i<N; ++i) {
39
40 ...
41
42 // Another very important loop
43 for (int i=1; i<=N; ++i) {
44     foo[i] = bar[i] * i;
45
```

Alice's Local Repository



Bob's Local Repository



loops.cpp (commit E)

```
36
37 // Very important loop
38 for (int i=0; i<N; i++) {
39
40 ...
41
42 // Another very important loop
43 for (int i=0; i<N; i++) {
44     foo[i] = bar[i] * i;
45
```

Our First Workflow

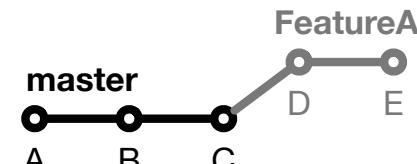
This process of collaborating *via* Git is called the **Centralized Workflow**

- See Atlassian/BitBucket for more information
- “Simple” to learn and “easy” to use
- Leverages local vs. remote repo dimension
 - Integration in local repo when local repos interact with remote repo
- What if you have many team members?
- What if developers only push once a month?
- What if team members works on different parts of the code?
- Working directly on master

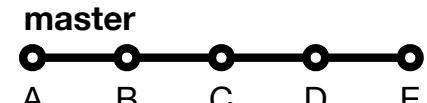
Branches

Branches are independent lines of development

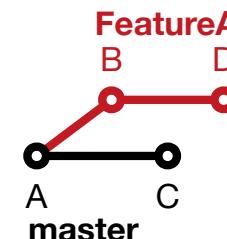
- Use branches to protect master branch
- Feature branches
 - Organize a new feature as a sequence of related commits in a branch
- Branches are usually combined or **merged**
- Develop on a branch, test on the branch, and merge into master
- Integration occurs at merge commits



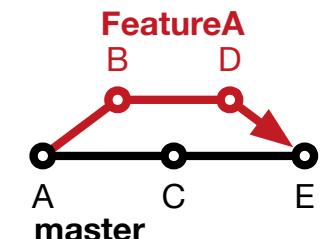
Fast-Forward



No Merge



Divergence

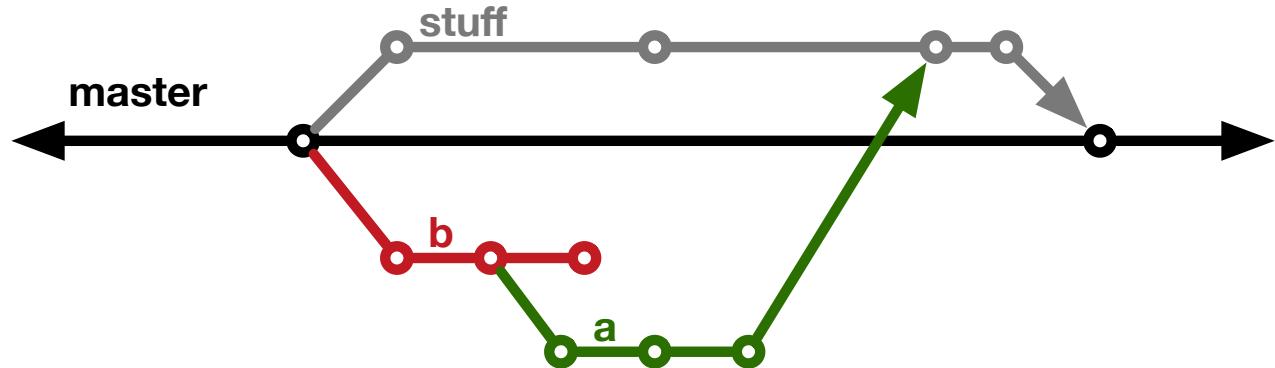


Merge Commit

Control Branch Complexity

Workflow policy is needed

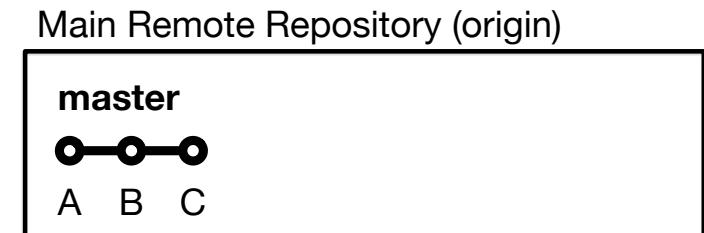
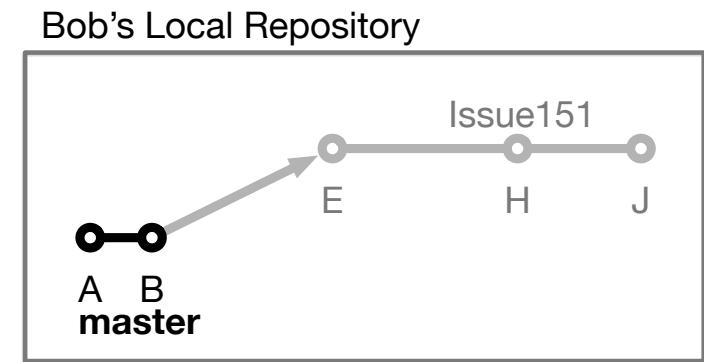
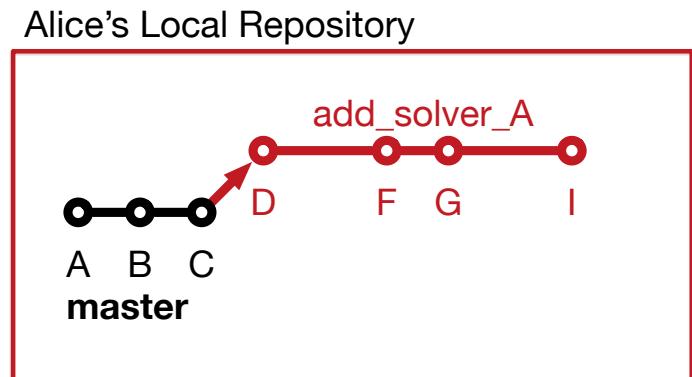
- Descriptive names or linked to issue tracking system
- Where do branches start and end?
- Can multiple people work on one branch?



Feature Branches

Extend Centralized Workflow

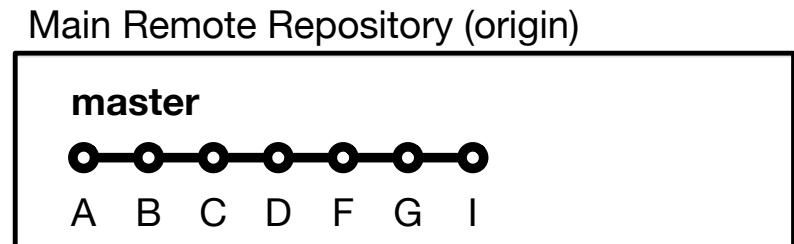
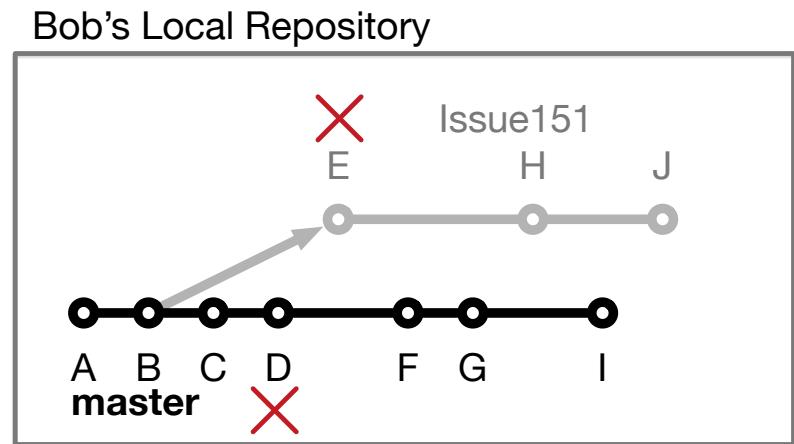
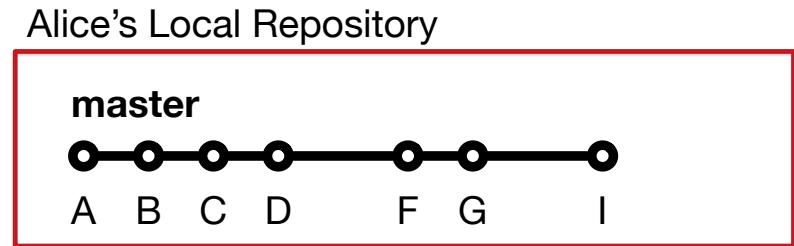
- Remote repo has commits A & B
- Bob pulls remote to synchronize local repo to remote
- Bob creates local feature branch based on commit B
- Commit C pushed to remote repo
- Alice pulls remote to synchronize local repo to remote
- Alice creates local feature branch based on commit C
- Both develop independently on local feature branches



Feature Branch Divergence

Alice integrates first without issue

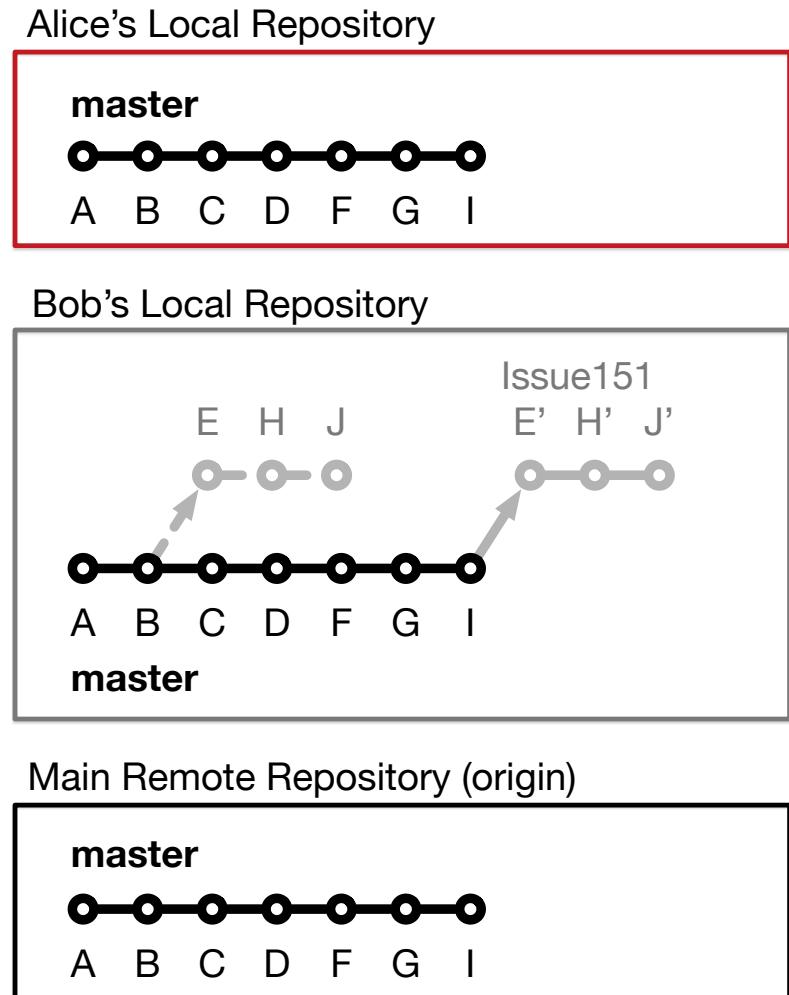
- Alice does fast-forward merge to local master
- Alice deletes local feature branch
- Alice pushes master to remote
- Meanwhile, Bob pulls master from remote and finds Alice's changes
- Merge conflict between commits D and E



Feature Race Condition

Integration occurs on Bob's local repo

- Bob laments not having fast-forward merge
- Bob **rebases** local feature branch to latest commit on master
 - E based off of commit B
 - E' based off of Alice's commit I
 - E' is E integrated with commits C, D, F, G, I
- Merge conflict resolved by Bob & Alice on Bob's local branch when converting commit E into E'
- Can test on feature branch and merge easily and cleanly



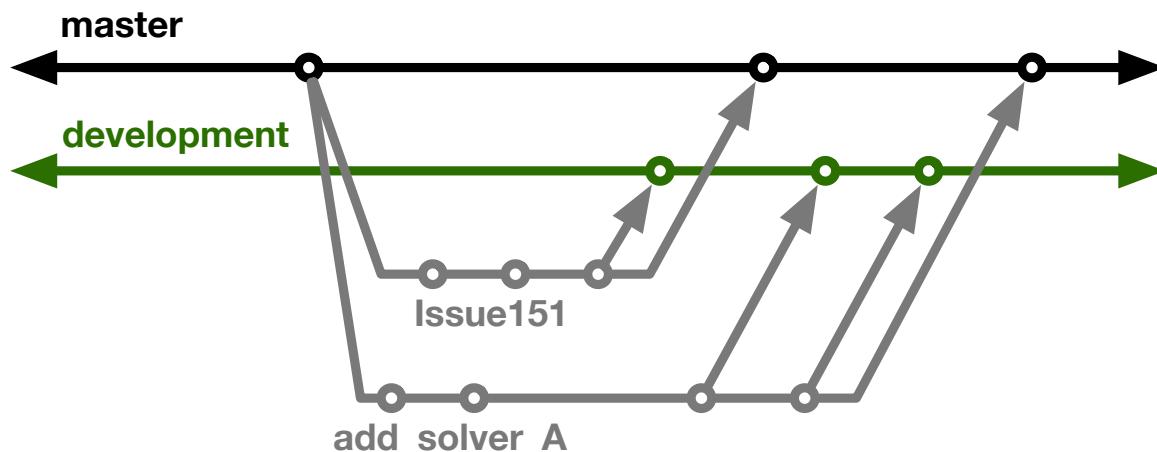
Feature Branches Summary

- Multiple, parallel lines of development possible on single local repo
- Easily maintain local master up-to-date and useable
- Integration with rebase on local repo is safe and can be aborted
- Testing before updating local and remote master branches
- Rebase is advanced Git command
 - Rebase can cause complications and should be used carefully.
- Hide actual workflow
 - History in repo is not represent actual development history
 - Less communication
 - Fewer back-ups using remote repo
- Does it scale with team size? What if team integrates frequently?
- Commits on master can be broken
- See [Atlassian/BitBucket](#) for a richer Feature Branch Workflow

More Branches

Branches with infinite lifetime

- Base off of master branch
- Exist in all copies of a repository
- Each provides a distinct **environment**
 - Development vs. pre-production



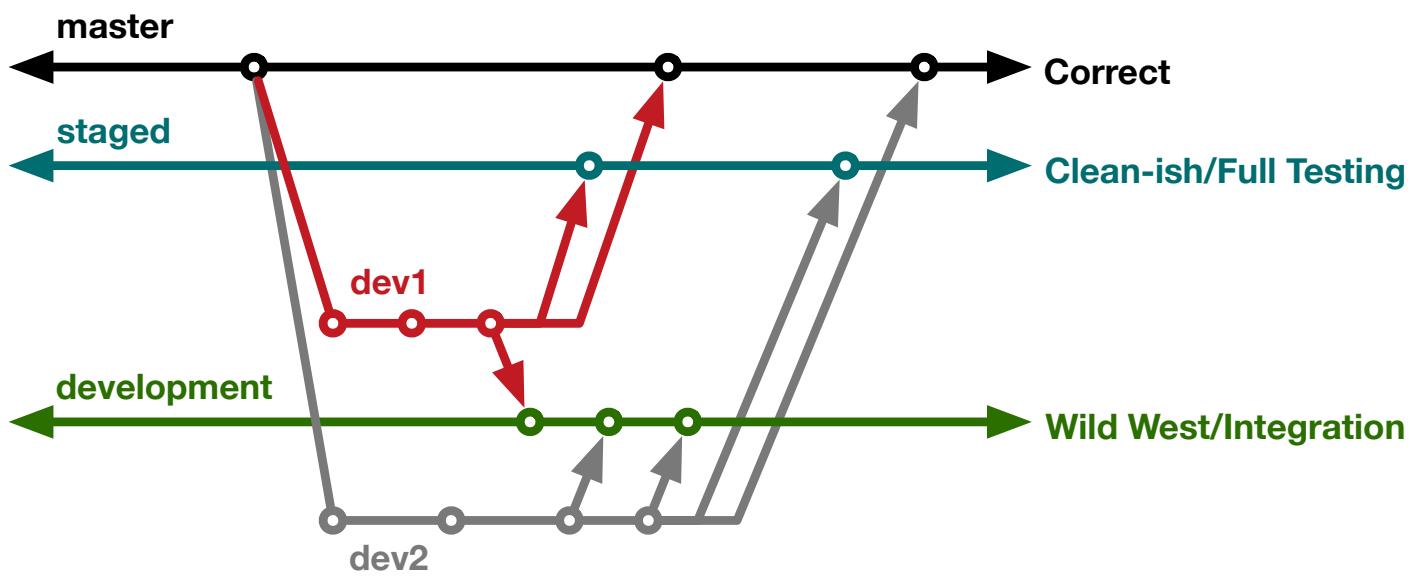
Current FLASH5 Workflow

Test-driven workflow

- Feature branches start and end with master
- All feature branches are merged into development for integration & manual testing
- All feature branches are then merged into staged for full, automated testing

Workflow designed so that

- All commits in master are in staged & development
- infinite branches don't diverge
- Merge conflicts first exposed on development



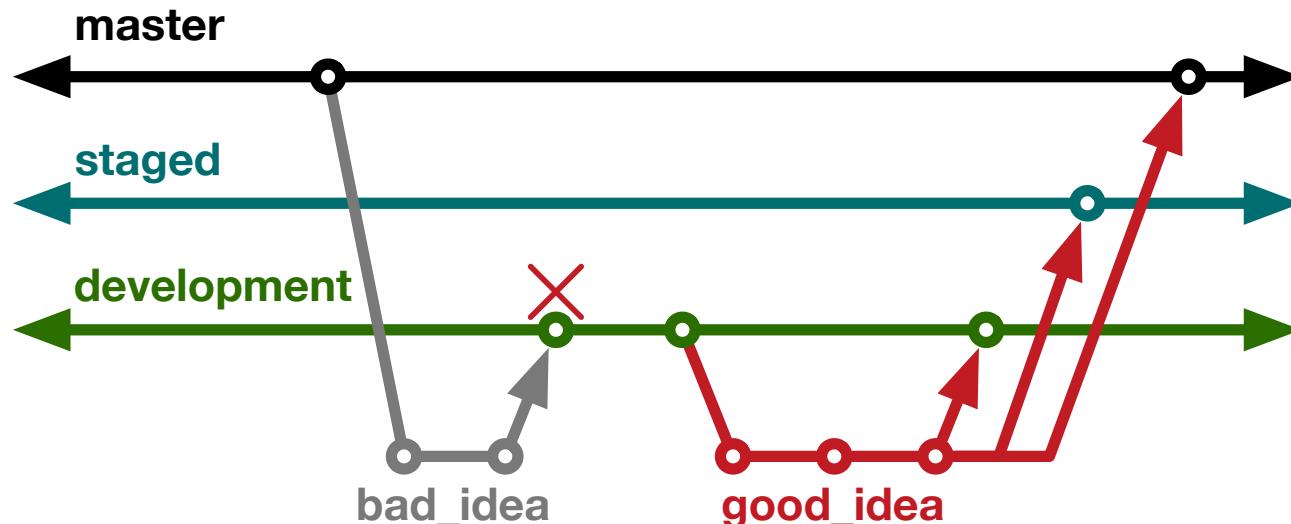
Branch Rules

Why base feature branches off master?

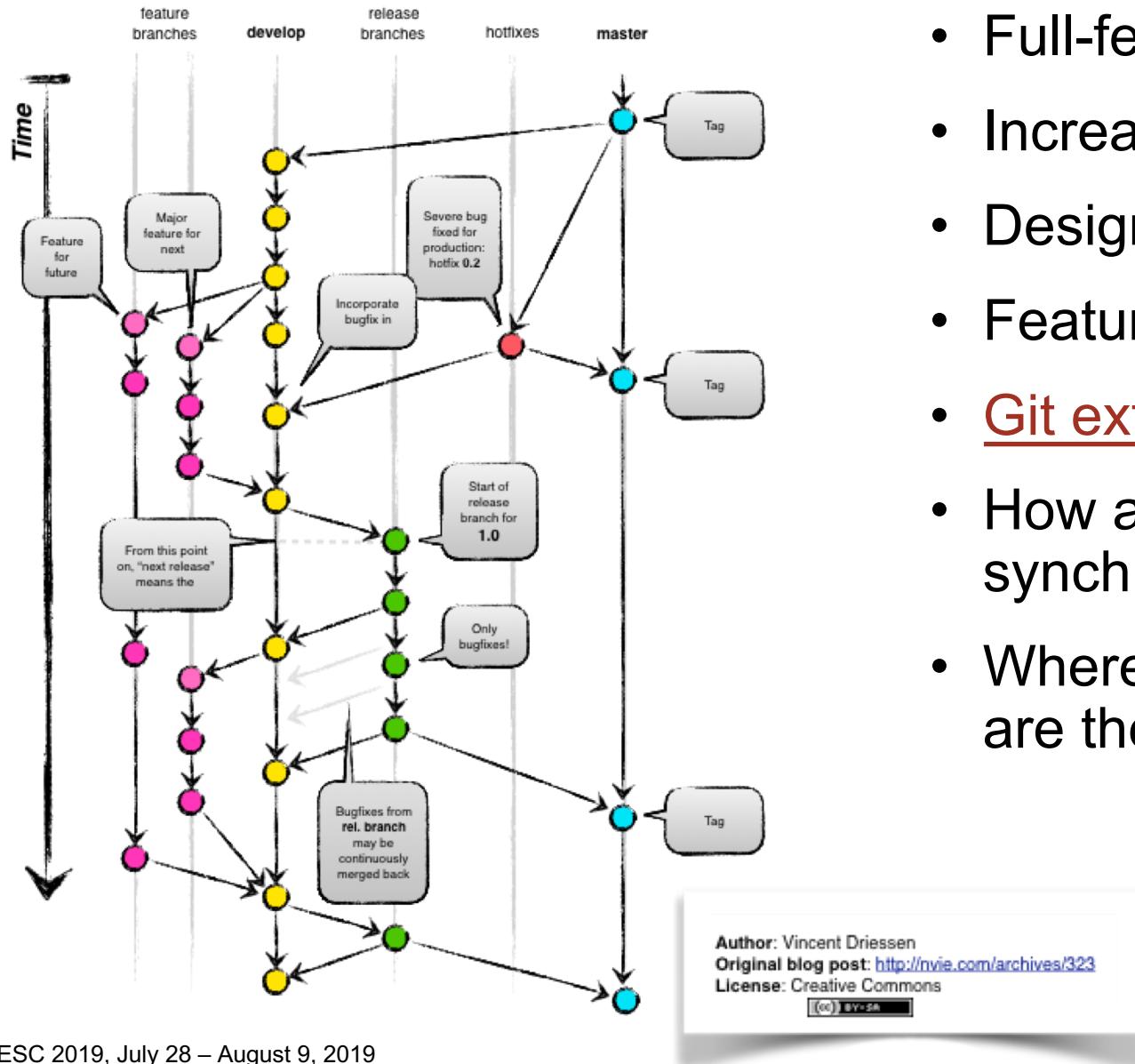
- Start from correct, verified commit
- Clean and simple to learn/enforce
- Isolate master from integration environment

Motivates more rules

- Development never merged into another branch
- Staged never merged into another branch



Git Flow



- Full-featured workflow
- Increased complexity
- Designed for SW with official releases
- Feature branches based off of develop
- Git extensions to enforce policy
- How are develop and master synchronized?
- Where do merge conflicts occur and how are they resolved?

GitHub Flow

<http://scottchacon.com/2011/08/31/github-flow.html>

- Published as viable alternative to Git Flow
- No structured release schedule
- Continuous deployment & continuous integration allows for simpler workflow

Main Ideas

1. All commits in master are **deployable**
2. Base feature branches off of master
3. Push local repository to remote constantly
4. Open Pull Requests early to start dialogue
5. Merge into master after Pull Request review

GitLab Flow

https://docs.gitlab.com/ee/workflow/gitlab_flow.html

- Published as viable alternative to Git Flow & GitHub Flow
- Semi-structured release schedule
- Workflow that simplifies difficulties and common failures in synchronizing infinite lifetime branches

Main Ideas

- Master branch is staging area
- Mature code in master flows downstream into pre-production & production infinite lifetime branches
- Allow for release branches with downstream flow
 - Fixes made upstream & merged into master.
 - Fixes cherry picked into release branch

Things to Think About When Choosing a Git Workflow

Want to establish a clear set of policies that

- results in correct code on a particular branch (usually master),
- ensures that a team can develop in parallel and communicate well,
- minimizes difficulties associated with parallel and distributed work, and
- minimizes overhead associated with learning, following, and enforcing policies.

Adopt what is good for your team

- Consider team culture and project challenges
- Assess what is and isn't feasible/acceptable
- Start with simplest and add complexity where and when necessary

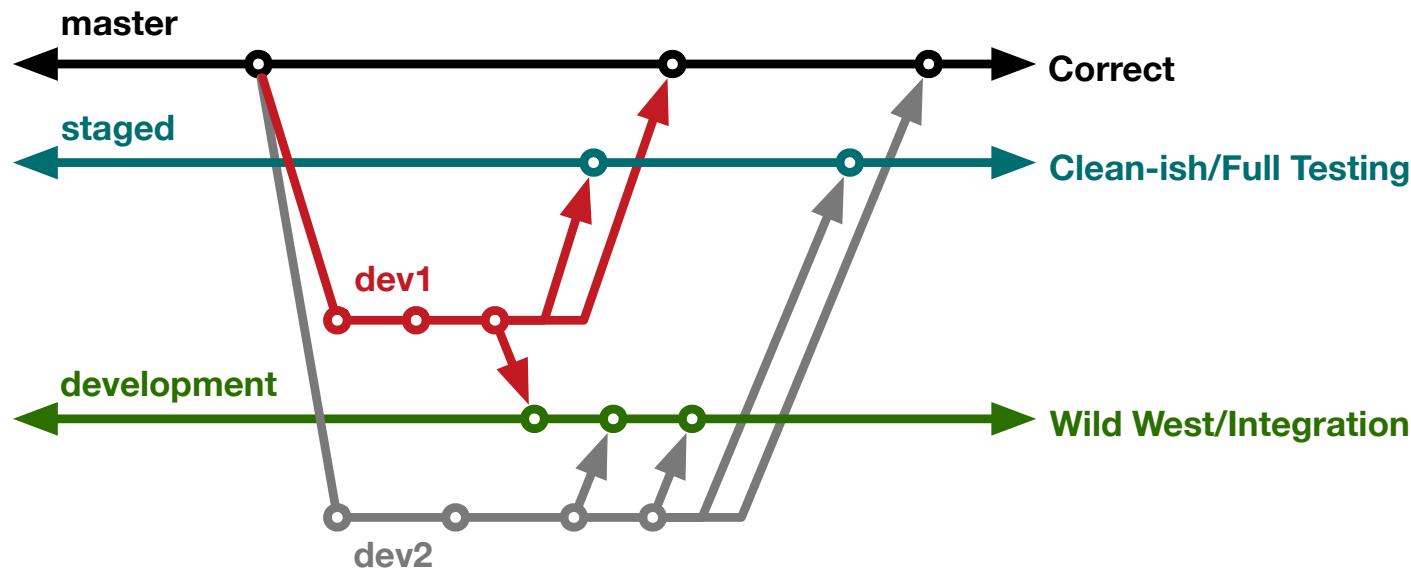
Agenda

Time	Module	Topic	Speaker
9:30am-10:15am	01	Objectives, Motivation, & Overview	Katherine Riley, ANL
<i>10:15am-10:45am</i>		<i>Break</i>	
10:45am-11:30am	02	Requirements & Test-Driven Development	Jared O'Neal, ANL
11:30am-12:30pm	03	Software Design & Testing	Anshu Dubey, ANL
<i>12:30pm-1:30pm</i>		<i>Lunch</i>	
1:30pm-2:15pm	04	Licensing	James Willenbring, SNL
2:15pm-3:15pm	05	Agile Methodologies & Useful GitHub Tools	James Willenbring, SNL
<i>3:15pm-3:45pm</i>		<i>Break</i>	
<i>3:45pm-4:15pm</i>	06	Git Workflows	Jared O'Neal, ANL
<i>4:15pm-4:55pm</i>	07	Code Coverage & Continuous Integration	Jared O'Neal, ANL
<i>4:55pm-5:30pm</i>	08	Software Refactoring & Documentation	Anshu Dubey, ANL

More Branch Rules

Is staged really necessary?

- Contains only changes intended for master
- No integration means cleaner branch
- Allows for extra stage of testing with more tests
- Extra buffer for protecting master branch



Merge Conflicts

How are merge conflicts resolved in FLASH5 Workflow?

- Merge conflict with master means merge conflict with staged and development
- We want to avoid conflict resolution when merging into master
- Directly on feature branch if resolution is there
- One idea is to merge master into feature branch

