

An introduction to GitLab workflows

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Git Fundamentals



What is it?

- Distributed version control system created to support software collaboration
- Supports various workflows, and provides robust tools for managing branches and merging, facilitating both individual and collaborative work
- [GitLab](#) and [GitHub](#) are a few web interfaces that integrate with Git, providing project hosting, continuous integration, code review, and many other enhancements to the core Git functionalities



Commits, history and branches

- A **commit** records an individual set of changes to files and is identified by a hash
- Every commit has a parent
- Lineage of commits forms the **history**
- A **branch** is a pointer to a commit, allowing navigation and extension of history



How you use it

- Clone
 - Command: `git clone`
 - Creates a local copy of a remote repository
- Commits
 - Commands: `git add`, `git commit`
 - Creates a new commit, its parent will be the current branch pointer, updates the branch pointer



How you use it

- Branches
 - Commands: `git branch [-m/c/d]`, `git switch`
 - Creates a new pointer to an existing commit
- Merging and branch management
 - Commands: `git fetch`, `git pull`, `git rebase`, `git merge`, `git push`
 - Merging: Integrates completed features
 - Branch Management: Organizes lines of development

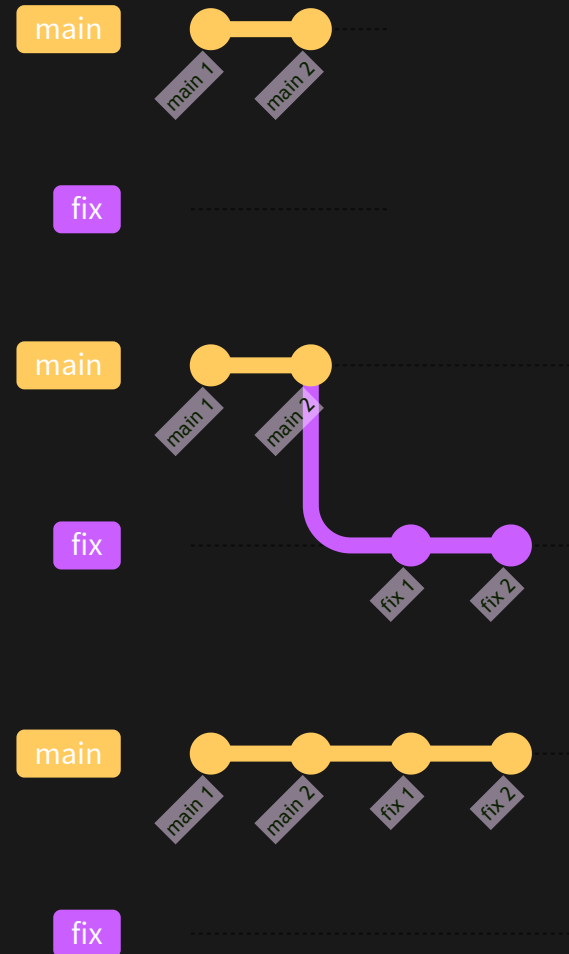


In practical terms

```
1 git clone <repository-url>
2 git branch fix
3 git switch fix
```

```
1 git add .
2 git commit
3 ...
```

```
1 git switch main
2 git merge fix
```

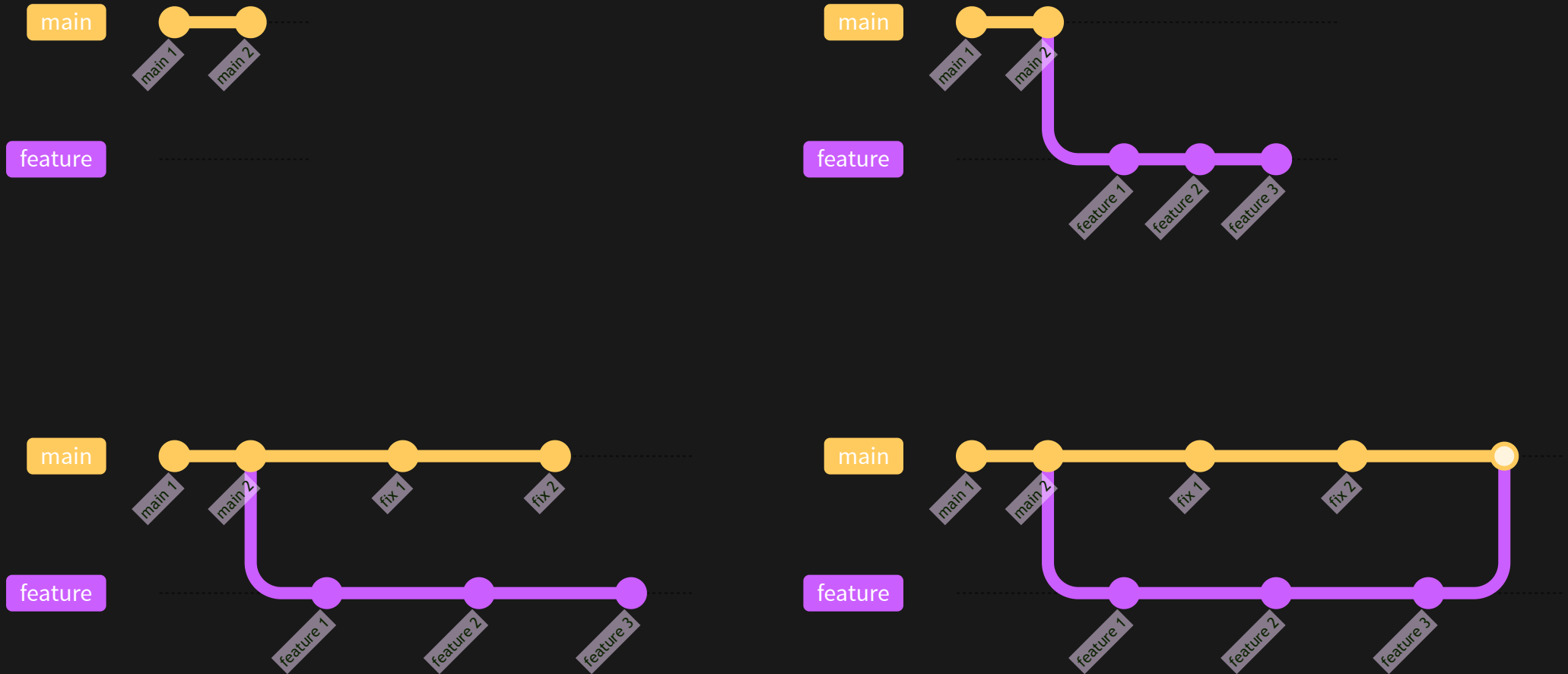


Fast-forward (FF) merge

- Default type of merge (when possible)
- Possible only when there is no divergence between target and source branches
- It simply makes the target branch point to the source branch
- No merge commit is created



Things get more complicated



Three-way merge

- When a FF merge is not possible Git will resort to a Three-way merge
- Takes the common ancestor of the two branches and applies chunks from branch tips
- Creates a merge commit linking the two histories and solving possible conflicts
- History is no longer linear



Git history



Types of history

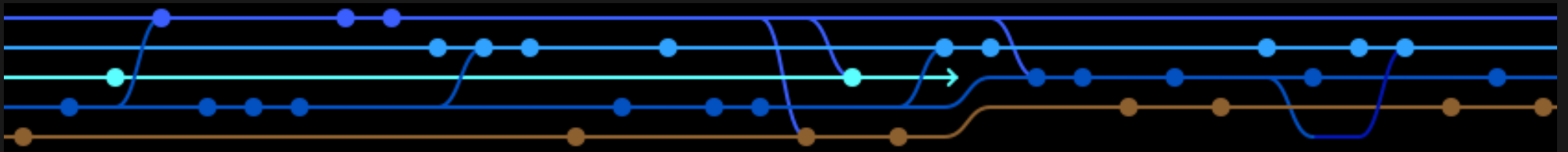
linear



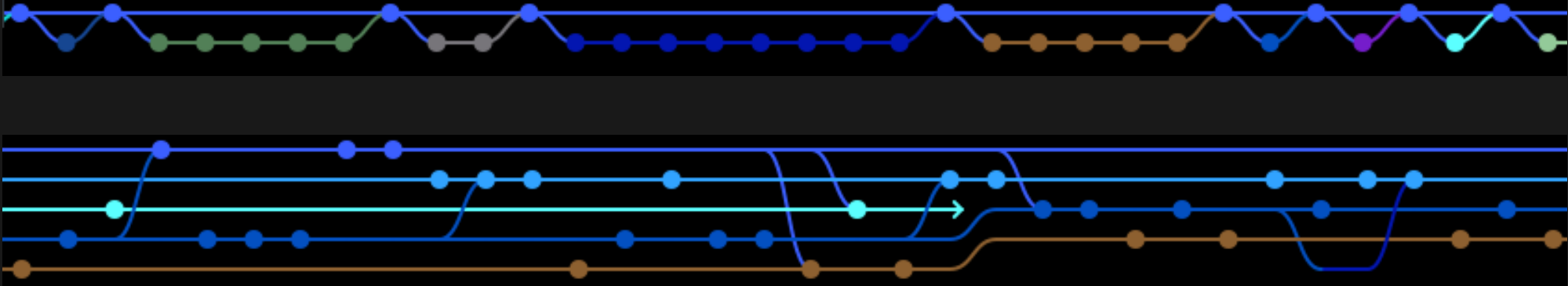
semi-linear



non-linear



Benefits of a (semi-) linear history

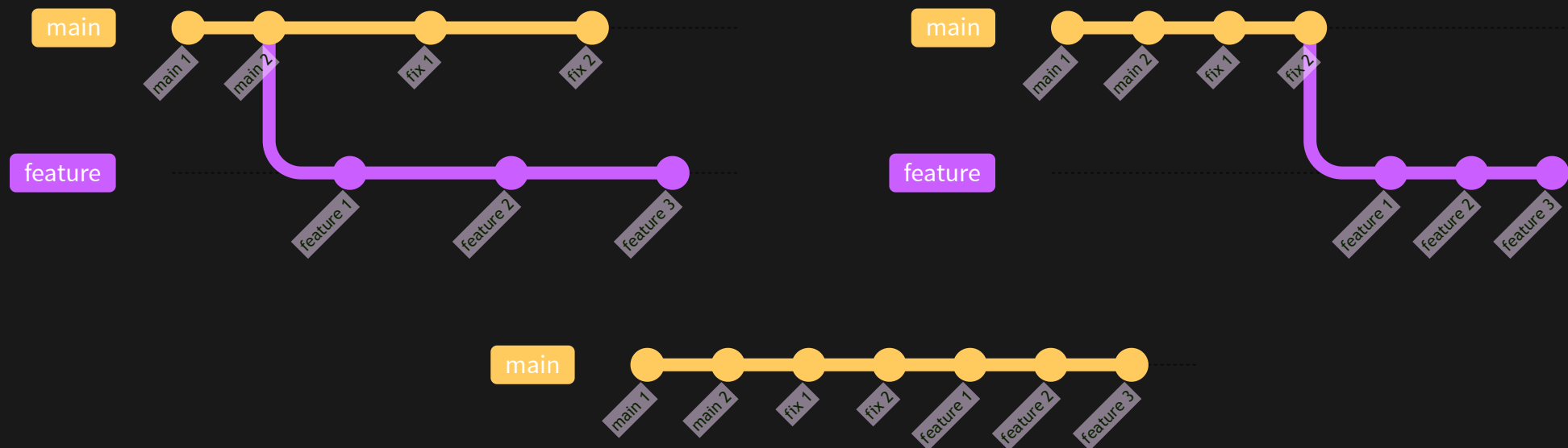


- Linear and semi-linear histories are usually cleaner and easier to understand than non-linear ones
- The context of all commits is preserved
- All commits can (and should) always yield a stable state
- Searching and fixing bugs is much easier using **bisect**



Rebase

- [Git rebase](#) allows you to always have (semi-) linear history
- It rewrites a sequence of commits on a new base
- Think of git history as a recipe not a work log
- Conflicts are solved for every new applied commit



Rebase is great, but caution ...

- Always rebase children on parents
- Since commits are rewritten you lose previous hashes
- New commits conflict with remote repositories and require a forced push
- Use the `--force-with-lease` flag to prevent wrong accidental overwrites
- Important shared branches should block force pushes (and ideally commits in general)



How to keep your history tidy

- Long-lived branches are usually a problem

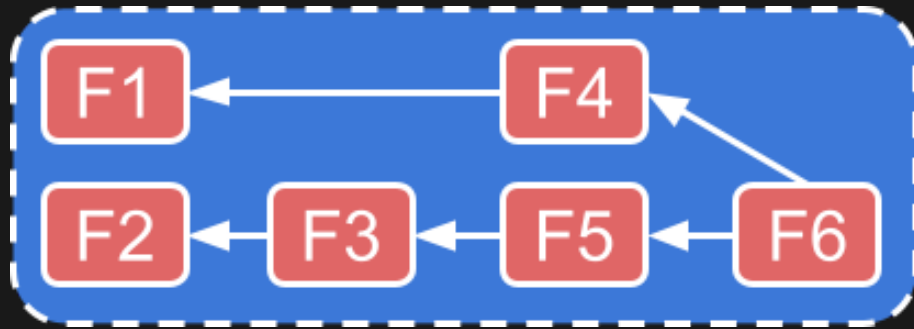


Feature



How to keep your history tidy

- Long-lived branches are usually a problem



- Split your changes into their basic independent parts and merge them separately
- Make all your individual changes stable
- Do atomic commits (shortest distance)
- Rebase frequently to reduce conflicts
- Use automated tools and CI

Introduction to GitLab



GitLab in a Nutshell

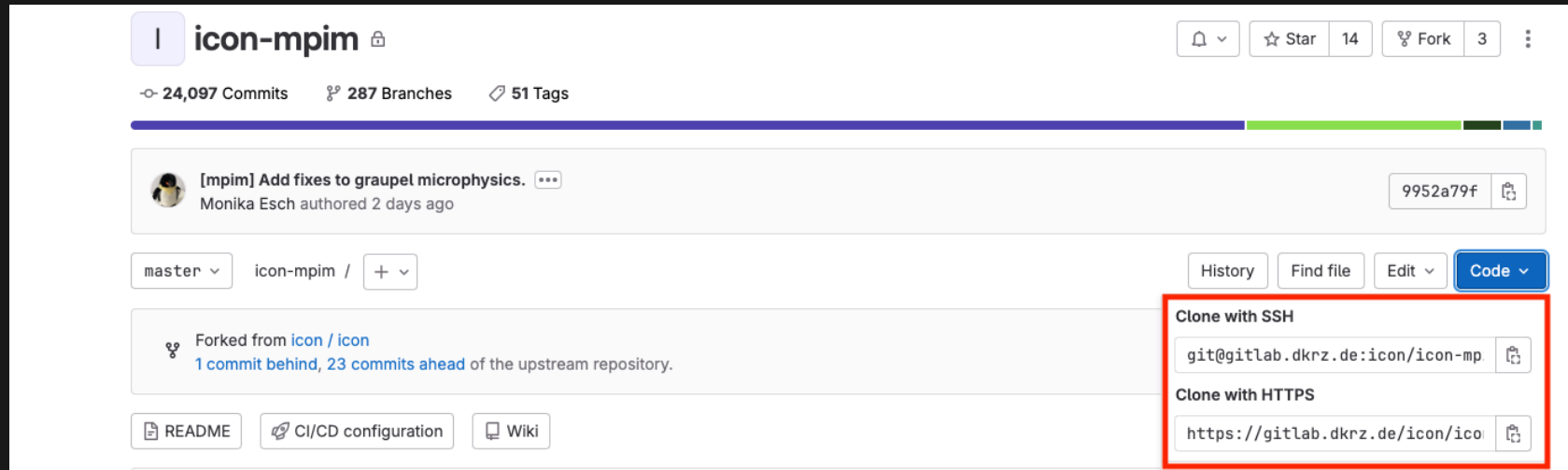
issues, wiki, pipelines, commit history, forks, merge requests

The screenshot displays the GitLab interface for the 'icon-mpim' project. The left sidebar is highlighted with a red box, showing navigation options: Project, Pinned, Issues (42), Merge requests (36), Wiki, Branches, Commits, Repository graph, Pipelines, Pipeline editor, and Releases. The main content area shows the project name 'icon-mpim', statistics (24,097 Commits, 287 Branches, 51 Tags), a recent commit by Monika Esch, and a table of repository files.

Name	Last commit	Last update
reuse	[mpim] Fix build system license	2 months ago



Clone repository from GitLab



The screenshot shows the GitLab interface for the repository 'icon-mpim'. At the top, it displays '24,097 Commits', '287 Branches', and '51 Tags'. Below this, a commit by 'Monika Esch' is visible. The 'Code' dropdown menu is open, showing two options: 'Clone with SSH' with the URL 'git@gitlab.dkrz.de:icon/icon-mp' and 'Clone with HTTPS' with the URL 'https://gitlab.dkrz.de/icon/icon'. The 'Code' menu is highlighted with a red box.

- Clone using HTTPS: requires username and password

```
1 git clone https://gitlab.dkrz.de/icon/icon-mpim.git
```

- Clone using SSH: requires ssh-keys

```
1 git clone git@gitlab.dkrz.de:icon/icon-mpim.git
```



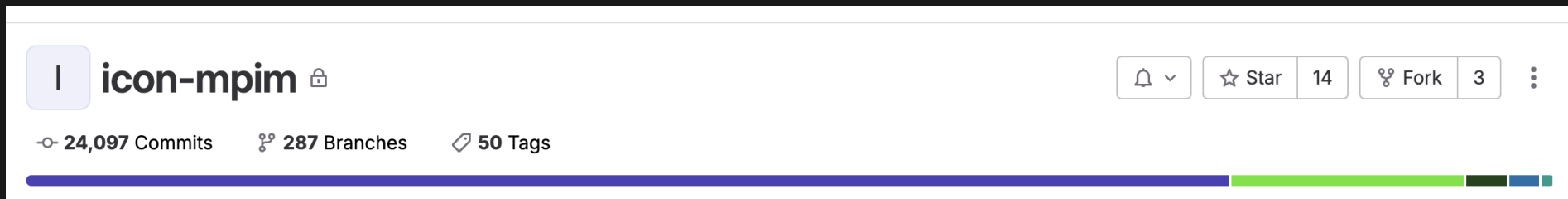
GitLab Authentication via ssh keys

- Needed once per dev environment
- Steps
 - Generate an ssh key
 - Add the ssh key using the `ssh-add`
 - Associate the private key with the host repo (`.ssh/config`)
 - Store the public key in GitLab: User → Preferences → SSH Keys → Add new key
 - More information can be found on [GitLab](#) documentation



Git Fork

- A copy of a repository that resides under the namespace of a user
- Purpose:
 - to contribute to someone else's project
 - to start a new project based on an existing one



Sync with the original repository

- Clone your Fork

```
1 git clone https://gitlab.com/your-username/repository.git
2 cd repository
```

- Add the original repo as a remote

```
1 git remote add upstream https://gitlab.com/original-owner/repository
```

- Fetch and Merge changes

```
1 git fetch upstream
2 git checkout main
3 git merge upstream/main
```

- Push the Merged change



Fork vs Branch

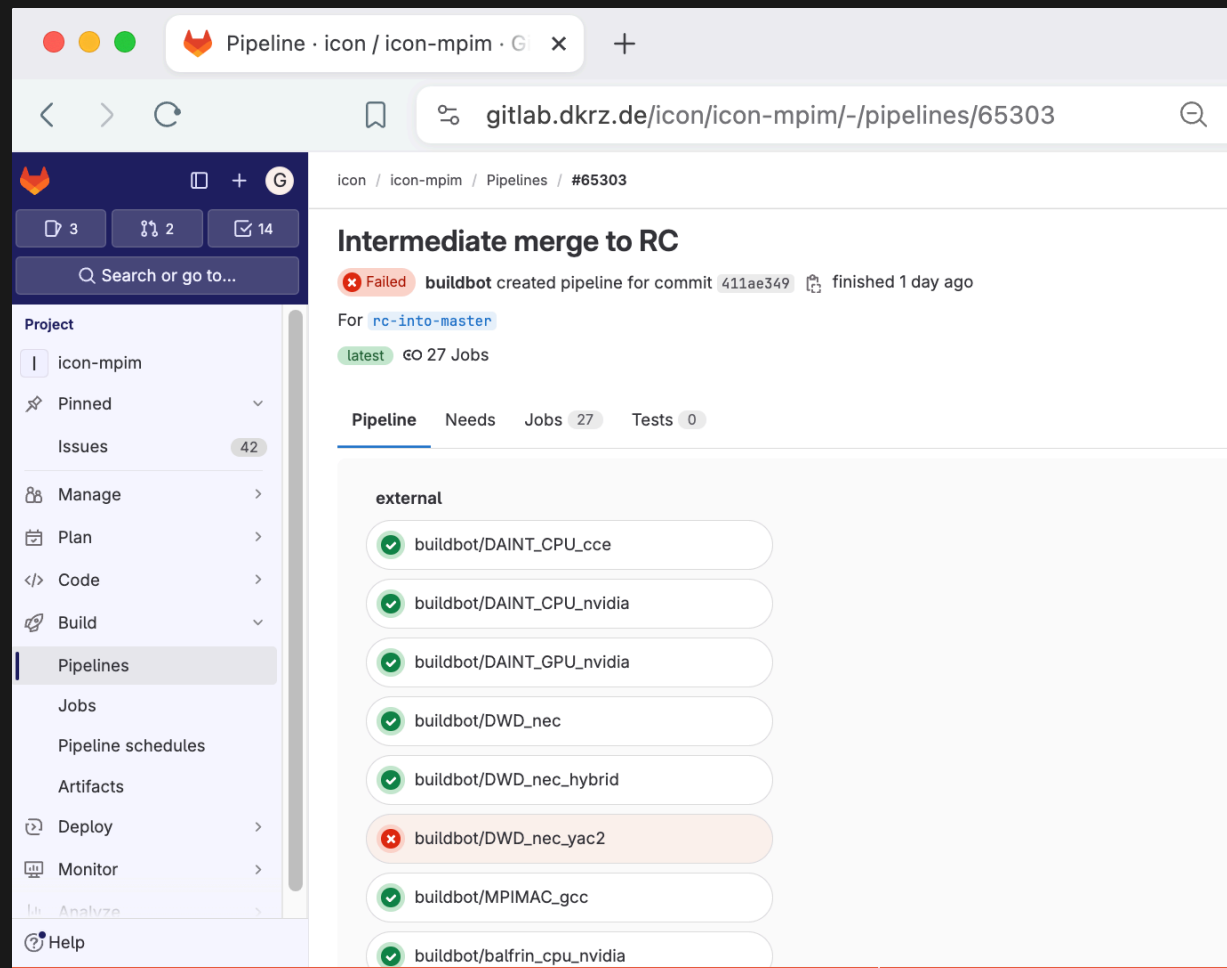


Features of GitLab



GitLab Continuous Integration (CI)

Run unit- and functional tests via internal runners or via **buildbot** grouped in **pipelines**



The screenshot displays the GitLab CI pipeline interface for the project 'icon / icon-mpim'. The pipeline is titled 'Intermediate merge to RC' and is in a 'Failed' state. The failure message indicates that the 'buildbot' runner created a pipeline for commit '411ae349' which finished 1 day ago. The pipeline is for the 'rc-into-master' branch and is the 'latest' version with 27 jobs and 0 tests. The pipeline is currently running on the 'external' runner. The jobs listed are:

- buildbot/DAINT_CPU_cce (Success)
- buildbot/DAINT_CPU_nvidia (Success)
- buildbot/DAINT_GPU_nvidia (Success)
- buildbot/DWD_nec (Success)
- buildbot/DWD_nec_hybrid (Success)
- buildbot/DWD_nec_yac2 (Failed)
- buildbot/MPIMAC_gcc (Success)
- buildbot/balfrin_cpu_nvidia (Success)



GitLab Continuous Integration (CI)

Run unit- and functional tests via internal runners or via **buildbot** grouped in **pipelines**

The screenshot displays the GitLab CI pipeline interface for a project named 'muphys-cpp'. The pipeline is titled 'Merge branch 'kokkos-opt' into 'main'' and is in a 'Passed' state. It was created by 'Georgiana Mania' for commit 'b2592384' and finished 1 day ago. The pipeline is for the 'main' branch and consists of 20 jobs, with a total duration of 5 minutes and 23 seconds, and a 3-second queue time. The pipeline is grouped by 'Stage' and 'Job dependencies'. The stages and their jobs are:

Stage	Jobs
lint	code-format
check	gcc-cpu-kokkos-double, gcc-cpu-kokkos-openmp-double, gcc-cpu-kokkos-single, gcc-cpu-omp-double, gcc-cpu-omp-single, gcc-cpu-seq-double, gcc-cpu-seq-single, gcc-gpu-kokkos-double, intel-cpu-seq-double, intel-cpu-seq-single, intel-cpu-sycl-double
doc	gen_doxy_html
upload	pages
deploy	pages:deploy



GitLab Merge Request (MR)

The screenshot shows a GitLab Merge Request (MR) page for the project 'icon / icon-mpim'. The MR is titled 'Vertical diffusion cleanup of tmx' and was requested by Moritz Waldmann 2 weeks ago. The MR is currently in the 'Open' state and is targeting the 'master' branch. The MR description includes a generalization of the vertical diffusion in the 'tmx' package, with three numbered points detailing the changes to the numerics and physics parts, and the inclusion of new functions in the 'Compute' function.

The MR has a 'Merge request pipeline #65501' that has passed, with a 'View 0 exposed artifacts' link. The MR is also marked as 'Ready to merge by members who can write to the target branch.' and has 'Approval is optional' set.

The 'Activity' section shows the following actions:

- Moritz Waldmann added the 'WarmWorld' label 2 weeks ago.
- Moritz Waldmann requested review from @m212005 2 weeks ago.
- Moritz Waldmann added 2 commits 2 weeks ago:
 - 8d58237f - 1 commit from branch master
 - e919cd8f - Generalization of the vertical diffusion in the tmx package. The numerics part...

The right sidebar shows 0 Assignees, 1 Reviewer (Reiner Schnur), 1 Label (WarmWorld), 0 Milestones, and 3 Participants.




MR - Create a new one

The screenshot displays the GitHub interface for the repository 'icon / icon-mpim / Repository'. At the top, there's a navigation bar with the repository name and a search bar. Below this, a commit by Pradipta Samanta is shown, with a commit hash 'f463ca3a'. The repository is a fork of 'icon / icon', with 1 commit behind and 118 commits ahead of the upstream repository. A table lists the repository's files and their last commit details.

Name	Last commit	Last update
📁 .reuse	[mpim] Fix build system license	3 months ago
📁 LICENSES	[mpim] Fix build system license	3 months ago
📁 config	Removed SWAPDIM from FCFLAGS and added it as an ...	3 weeks ago
📁 data	[mpim] Switch to RTE+RRTMGP 1.7	2 months ago
📁 doc	[nwp] Merge main into NWP master	1 month ago
📁 etc	[nwp] Merge main into NWP master	1 month ago
📁 externals	The value of max_ntracer is updated in math-support to...	3 weeks ago
📁 m4	[mpim] License headers for the build system	3 months ago
📁 run	[mpim] Intermediate merge to RC	1 month ago
📁 schedulers/ecmwf	[dkrz] Add license to everything but src, support and ex...	4 months ago



MR - Create a new one


+
+

1
4
14

Project

- I icon-mpim
- Pinned v
- Issues 42
- Merge requests 36
- Wiki
- Branches
- Commits
- Repository graph
- Pipelines
- Pipeline editor
- Releases

- Manage >
- Plan >
- Code >
- Build >
- Deploy >
- Monitor >
- Analyze >

icon / icon-mpim / Merge requests / **New**

New merge request

























From `icon/icon-mpim:feature-new-math-libraries` into `icon/icon:main` [Change branches](#)

Title (required)

Creating a new merge request

Mark as draft
Drafts cannot be merged until marked ready.

Description

Preview | **B** *I*  |                       

in some files inside ocean

Switch to rich text editing [M]

Merge options

- Delete source branch when merge request is accepted.
- Squash commits when merge request is accepted. [?](#)

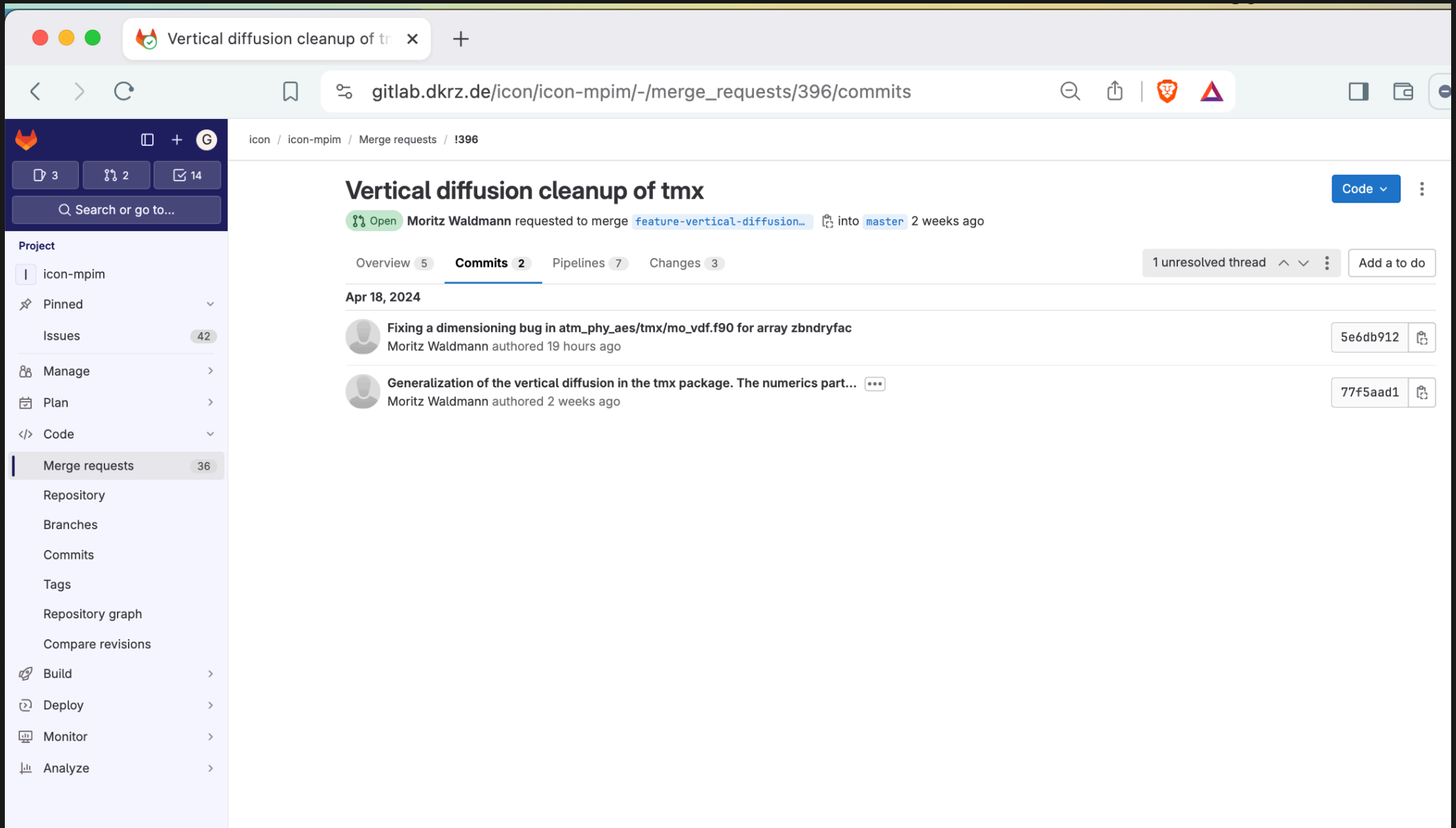
Contribution

Allow commits from members who can merge to the target branch. [About this feature.](#)
Not available for private projects

Create merge request
Cancel



MR - View commit history



The screenshot shows a web browser window displaying a GitLab merge request (MR) page. The browser's address bar shows the URL `gitlab.dkrz.de/icon/icon-mpim/-/merge_requests/396/commits`. The page title is "Vertical diffusion cleanup of tmx". The merge request was requested by Moritz Waldmann to merge the `feature-vertical-diffusion...` branch into `master` 2 weeks ago. The page shows a list of commits under the heading "Apr 18, 2024". The first commit is "Fixing a dimensioning bug in atm_phy_aes/tmx/mo_vdf.f90 for array zbdryfac" by Moritz Waldmann, authored 19 hours ago, with commit hash `5e6db912`. The second commit is "Generalization of the vertical diffusion in the tmx package. The numerics part..." by Moritz Waldmann, authored 2 weeks ago, with commit hash `77f5aad1`. The left sidebar shows the project navigation menu with "Merge requests" selected, indicating 36 items. The top navigation bar shows 3 issues, 2 pull requests, and 14 messages.

Vertical diffusion cleanup of tmx

Open Moritz Waldmann requested to merge `feature-vertical-diffusion...` into `master` 2 weeks ago

Overview 5 Commits 2 Pipelines 7 Changes 3

1 unresolved thread Add a to do

Apr 18, 2024

Fixing a dimensioning bug in `atm_phy_aes/tmx/mo_vdf.f90` for array `zbdryfac`
Moritz Waldmann authored 19 hours ago `5e6db912`

Generalization of the vertical diffusion in the `tmx` package. The numerics part...
Moritz Waldmann authored 2 weeks ago `77f5aad1`



MR - Pipeline status

The screenshot shows the GitLab interface for a merge request (MR) titled "Vertical diffusion cleanup of tmx". The pipeline status is displayed in a table with columns for Status, Pipeline, Created by, and Stages. The pipeline is currently in a "Passed" state, and the table lists several pipeline runs with their respective IDs and commit hashes.

Vertical diffusion cleanup of tmx

Open Moritz Waldmann requested to merge feature-vertical-diffusion... into master 2 weeks ago

Overview 5 Commits 2 Pipelines 7 Changes 3

1 unresolved thread Add a to do

Status	Pipeline	Created by	Stages
Passed	Fixing a dimensioning bug in atm_phy_aes/tmx/... #65501 1 396 -> 5e6db912 latest merge request		✓
Passed	Generalization of the vertical diffusion in the t... #65492 1 396 -> 77f5aad1 merge request		✓
Skipped	Generalization of the vertical diffusion in the t... #64852 1 396 -> cb18964f merge request		
Passed	Generalization of the vertical diffusion in the t... #64595 1 396 -> 85a96903 merge request		✓
Passed	Generalization of the vertical diffusion in the t... #63450 1 396 -> e919cd8f merge request		✓
Passed	Generalization of the vertical diffusion in the t... #63442 1 396 -> 63d2fa3e merge request		✓
Skipped	Generalization of the vertical diffusion in the t... #64851 1 feature-vertical-diffusion-cleanup -> cb18964f		



MR - Review code changes

gitlab.dkrz.de/icon/icon-mpim/-/merge_requests/396/diffs

icon / icon-mpim / Merge requests / !396

Vertical diffusion cleanup of tmx

Open Moritz Waldmann requested to merge feature-vertical-diffusion... into master 2 weeks ago

Overview 5 Commits 2 Pipelines 7 **Changes 3** 1 unresolved thread Add a to do

3 files +820 -517 Expand all files

Compare master and latest version

Search (e.g. *.vue) (#P)

src/atm_phy_aes/tmx

- mo_tm...nerics.f90 +113 -154
- mo_vdf.f90 +463 -361
- mo_vdf_atmo.f90 +244 -2

src/atm_phy_aes/tmx/mo_tm...nerics.f90 +113 -154 Viewed

```

@@ -31,7 +31,7 @@ MODULE mo_tm...nerics
31 31
32 32 PUBLIC :: &
33 33 & t_time_scheme_explicit_euler, &
34 - & diffuse_scalar_vertical_explicit, diffuse_scalar_vertical_implicit
34 + & diffuse_vertical_explicit, diffuse_vertical_implicit
35 35
36 36 TYPE, EXTENDS(t_time_scheme) :: t_time_scheme_explicit_euler
37 37 CONTAINS
@@ -59,185 +59,144 @@ CONTAINS
59 59
60 60 END SUBROUTINE step_forward_explicit_euler
61 61
62 - SUBROUTINE diffuse_scalar_vertical_explicit( &
63 - & ibs, ibe, ics, ice, &
64 - & dz, zf, &
65 - & k_ic, &
66 - & var, &
67 - & sfc_flx, &
68 - & top_flx, &
69 - & tend &
62 + ! Explicit vertical diffusion of any physical
63 + ! quantity. The coefficients of the system of
64 + ! equations are set in prepare_diffusion_matrix
65 + ! in mo_vdf_atmo. They are the same as for the
66 + ! implicit treatment.
67 + SUBROUTINE diffuse_vertical_explicit( &
68 + & ics, ice, & ! in
69 + & minlvl, maxlvl, & ! in
70 + & a, b, c, rhs, & ! in
71 + & var, & ! in
72 + & tend, & ! out
70 73 & )


```



MR - Rebase from UI

icon / icon-mpim / Merge requests / !352

uploading the jsc wrappers Code ▾ ⋮




 Open **Yen-Sen Lu** requested to merge `b381955-jsc-wrappers` into `master` 2 months ago



Overview 20 Commits 35 Pipelines 47 Changes 24 Add a to do

merge the wrappers created for JSC systems (for MSA (PSMPI) and for Atmo. only (OpenMPI))

original MR: !231 (closed)

Edited 2 months ago by Ralf Mueller


 0  0 

 **Merge request pipeline #63823 passed** 

Merge request pipeline passed for `c6c9aa5a` 2 weeks ago

[View 0 exposed artifacts](#)

8✓ Approval is optional ^

 **Merge blocked:** the source branch must be rebased onto the target branch. [Rebase without pipeline](#) [Rebase](#)

Merge details


- The source branch is [8 commits behind](#) the target branch.
- 1 commit will be added to `master`.
- Source branch will be deleted.

Activity All activity ▾ ⌵

- Ralf Mueller** added 3 commits 2 months ago
 - `a1434177` - update buildbot wrappers; add intel-2022 for cluster
 - `ff633df5` - add buildbot related scripting for building ICON
 - `0144ea30` - provide new jsc builders with wrappers

[Compare with previous version](#)

Assignee

 Ralf Mueller

0 Reviewers

None

Labels

None






Milestone

None

Time tracking +

No estimate or time spent

5 Participants



Recommendations



Tools

- [Git bisect](#) - Native Git tool for debugging, does a binary search through the commits
- [Git cherry-pick](#) - Native Git tool for applying a range of commits to a target
- [Graphical history viewers](#) such as [gitk](#) and [gitg](#)
- [meld](#) - Visual diff and merge tool
- There are many Git/GitLab plugins for Vim, Emacs and Visual Studio Code



Best practices for branches

- One branch == one functionality
- Keep branches short-lived and merge requests small
- Suggested naming convention
 - `feature-<branch-name>` - feature branch name
 - `bugfix-<branch-name>` - fix a bug
 - `<identifier>-<branch-name>` - for a personal branch
- Delete branch after the changes were merged



Best practices for commits

- Never commit code which does not compile!
- Keep commits atomic!
- Do not commit locally generated files, declare them in `.gitignore`
- Choose to commit often to save your working state
- Commit messages should have a summary of up to 50 chars and (if needed) a detailed comment
- Use pre-commit hooks for sanitizing your commits
- Use [conventional commits](#) and [semantic versioning](#)



GitLab Workflow

1. Open a GitLab issue (or assign yourself to one)
2. Create a branch
3. Develop in the new branch
4. Open a merge request and ask for code review
5. Rebase branch and solve conflicts
6. Merge the branch into main
7. Delete the branch
8. Close the GitLab issue



Thank you!



Documentation links

- [Git Book](#)
- [GitHub](#)
- [GitLab](#)
 - [pipelines](#)
 - [fork](#)
- [Git commands:](#)
 - [git-clone](#)
 - [git-commit](#)
 - [git-branch](#)
 - [git-merge](#)
 - [git-rebase](#)
 - [git-bisect](#)
 - [git-cherry-pick](#)

