Enabling Scientific Communities through ParaView

Code as Community

J. Fausty, M. Westphal and F. Mazen, PASC23

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Kitware / Leader in AI & scientific open source solutions

Software development
Based on open source tools
300+ active projects worldwide

Sustained Growth
Since creation of the company
100% employee-owned

230 employees Worldwide
6 offices across USA/Europe

65% staff with PhD or Master
High Level customer expertise

20+ years of expertise
Kitware USA, 1998
Kitware Europe, 2010

Revenue 2020
$39M consolidated

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Customers / Various fields of application

Academics

70+ academic institutions worldwide

Government agencies

50+ government agencies and national laboratories

Commercial companies

Over 500 commercial customers

Medical

Image processing, multimodal visualization, image registration & segmentation, assisted surgery, custom software…

Energy

HPC, in-situ simulation, scientific visualisation, particle flow, fluid mechanics, ground exploration…

Intelligence

Scene analysis, big data analysis, scientific visualization, flow analysis…

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Kitware / Services

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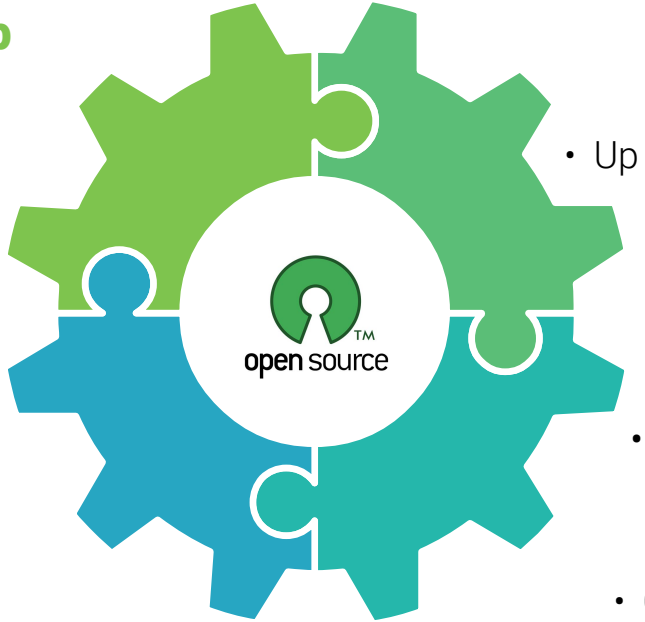
Open Source Benefits / Shifting Power

Source code ownership

- Source code ownership
- Integration with commercial software solutions

Cost effectiveness

- No license fee
- No vendor lock-in
- Shared maintenance costs



Flexibility and Agility

- Continuous development
- Up to date with new technologies
- Ability to customize and fix

Security

- Robust software and libraries
- Transparency
- Community effort
- Open Innovation mitigates risk

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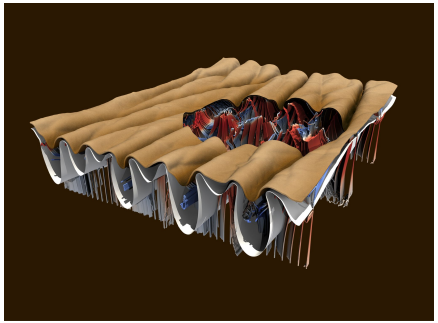
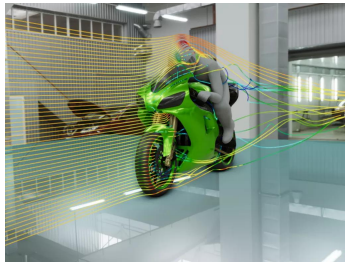
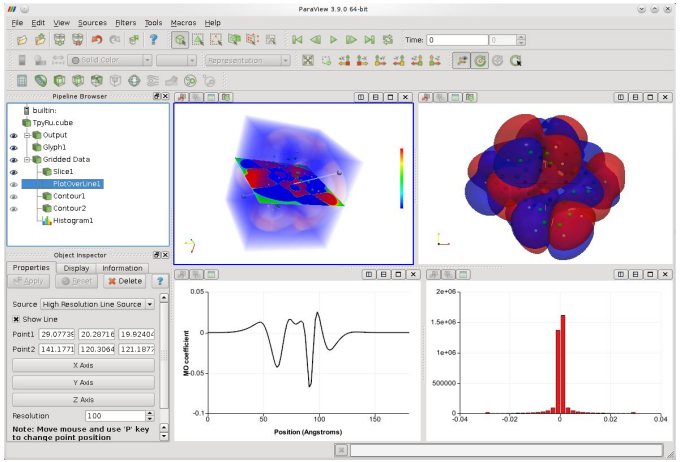
What is ParaView?

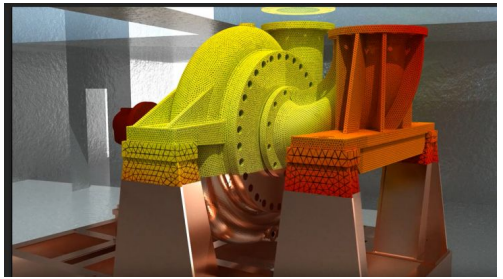
An application and architecture for display and analysis of massive scientific datasets.

- **Open-source**, multi-platform, data analysis and **visualization** application
- Analysis of **extremely large datasets** using **distributed computing** resources
- **Advanced rendering capabilities** such as physically based rendering and ray tracing solutions









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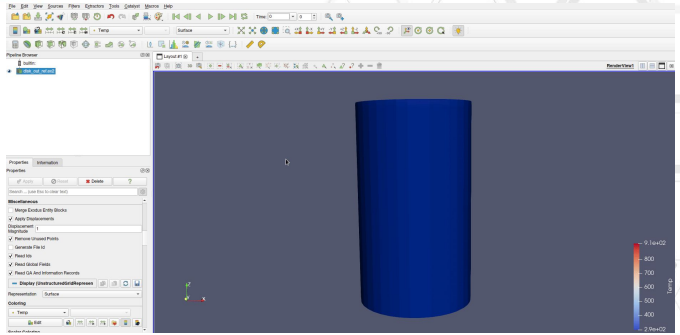
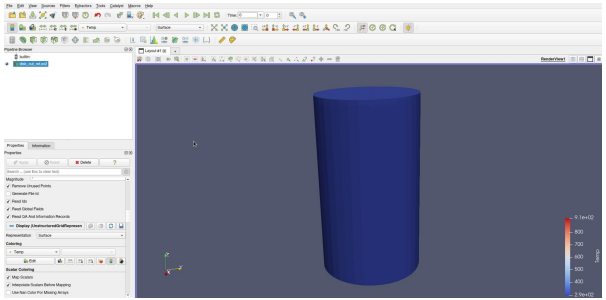
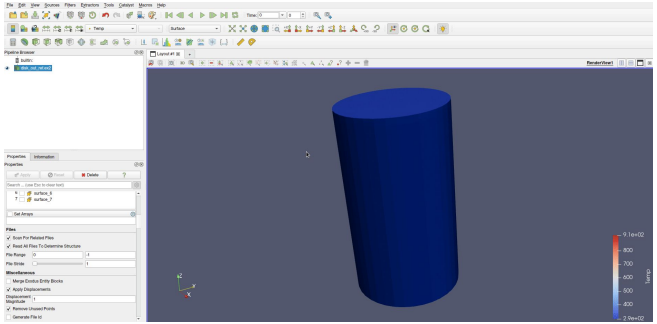
Quick demos

Streamlines

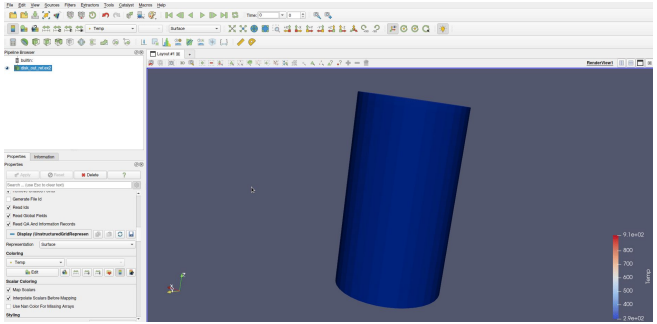


Clipping

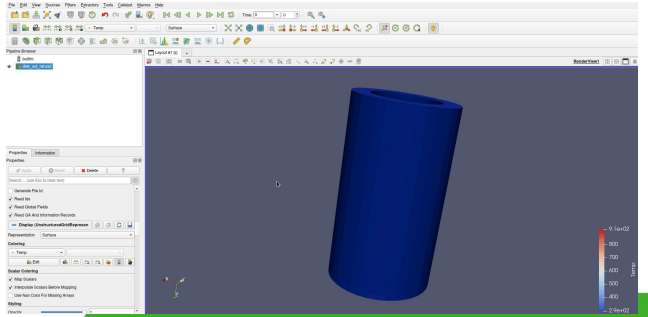




Contouring



Volume Rendering



Mesh Inspection

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... and much more

Some open-source ParaView facts and resources

- **6 month release** schedule
- **160 190 commits** (~ 3500 commits yearly basis)
- **349 contributors** (~20/month)
- Code hosted on a **GitLab** instance
- **~400K downloads/year**
- First public release in **2002**

Codebase (LOC)	**1,663,581**
Effort (est.)	**469 Person Years**

Community	Members	Topics per month
VTK Discourse	3000	100
ParaView Discourse	4500	100

ParaView GitLab: https://gitlab.kitware.com/paraview/paraview
Stats on the repository: https://www.openhub.net/p/ParaView
Discourse forum link: https://discourse.paraview.org/

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Identification of ParaView's Community Roles

User and Contributor Profiling

Who constitutes ParaView's community?

Users

Academia

Sandia National Laboratories

cnrs

Los Alamos NATIONAL LABORATORY EST.1943

Lawrence Livermore National Laboratory

CSCS Centro Svizzero di Calcolo Scientifico Swiss National Supercomputing Centre

OAK RIDGE National Laboratory

RWTH AACHEN UNIVERSITY

… and many more

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Industry

cea

EDF

TotalEnergies

NASA

JAXA Japan Aerospace Exploration Agency

CINECA

NVIDIA

intel

… and many more

Contributors

- **Kitware** (~98% of dev activity)
- **Professional Contributors*** (~ 1-2% of dev activity)
- **Hobbyists** (< 1% of dev activity)
- … but there is more to contributing than development

*contributors who do so as part of their work

Some Community User Profiles

Maria, Ph.D.

Occupation

Postdoctoral Researcher

ParaView Usage

Visualization of the results of her CFD simulation data on wind turbine optimization.

Desktop End User

Scripter

Hugo, Engineer

Occupation

Simulation and IT Support

ParaView Usage

Provide and develop curated ParaView deployments and workflows internally at XXX.

Deployer

Plugin Maintainer

Sarah, Engineer

Occupation

GPU Driver Development

ParaView Usage

Stress test, benchmark and evaluate new HPC GPU driver implementations using ParaView.

API Consumer

Benchmarker

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Some Community Contributor Profiles

Takashi, M.Sc.

Occupation

Ph.D. Student

ParaView Usage

Volume rendering of astronomy simulations of galaxy dynamics.

Community Support | Issue Opener

Anabelle, Engineer

Occupation

Automotive Acoustics Engineer

ParaView Usage

Visualization and automatic post-treatment of acoustic simulations of car geometries.

Issue Opener | Funder

Mathew, Engineer

Occupation

Senior Software Engineer at Kitware

ParaView Usage

Develops and maintains ParaView on a daily basis.

Developer | Maintainer

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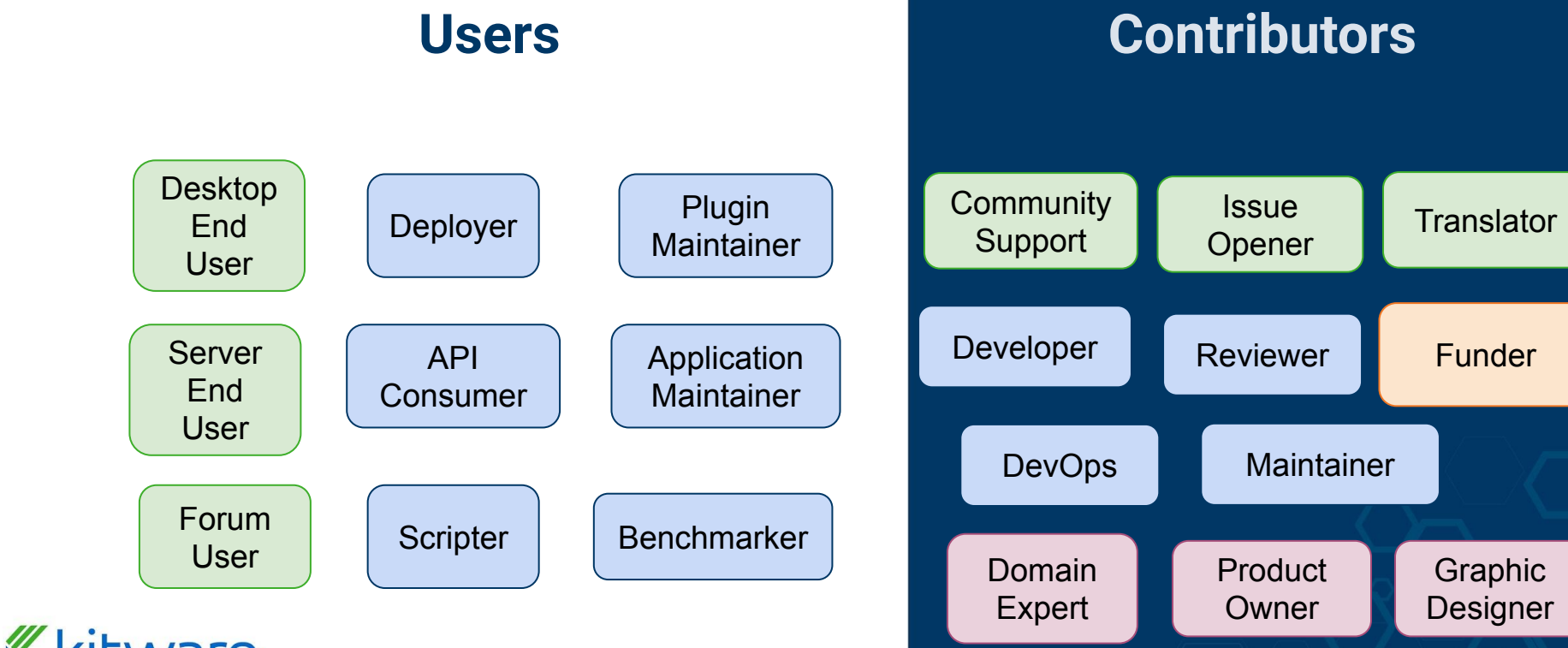
A bird's eye view of community roles



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ParaView's development drivers and feedback loops

Transient VTKHDF - Case Study

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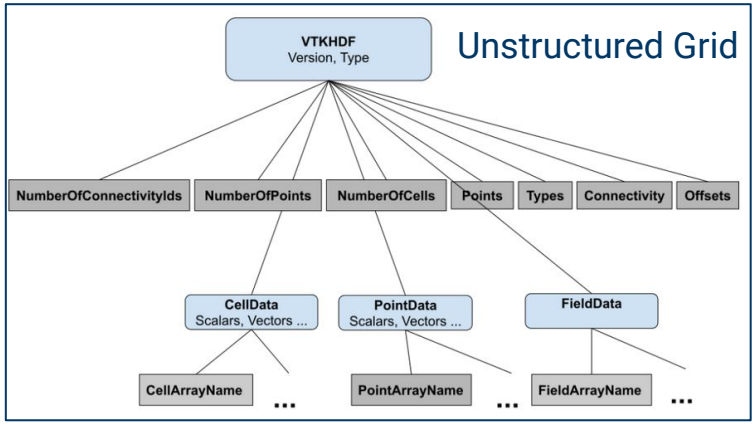
ParaView's development drivers and feedback loops: Case Study

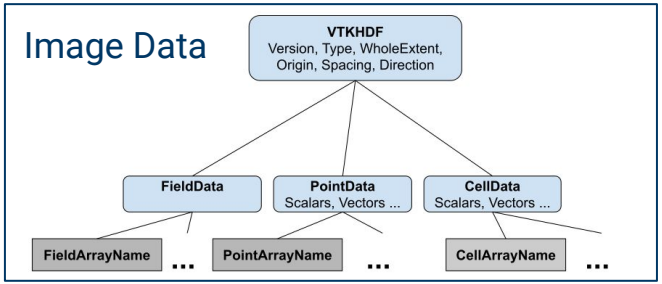
Funder

Funder Goals:

- Extend the existing VTKHDF file format specification to handle transient data
- Add the transient data support to the associated reader in VTK/ParaView

Existing designs:





https://docs.vtk.org/en/latest/design_documents/VTKFileFormats.html

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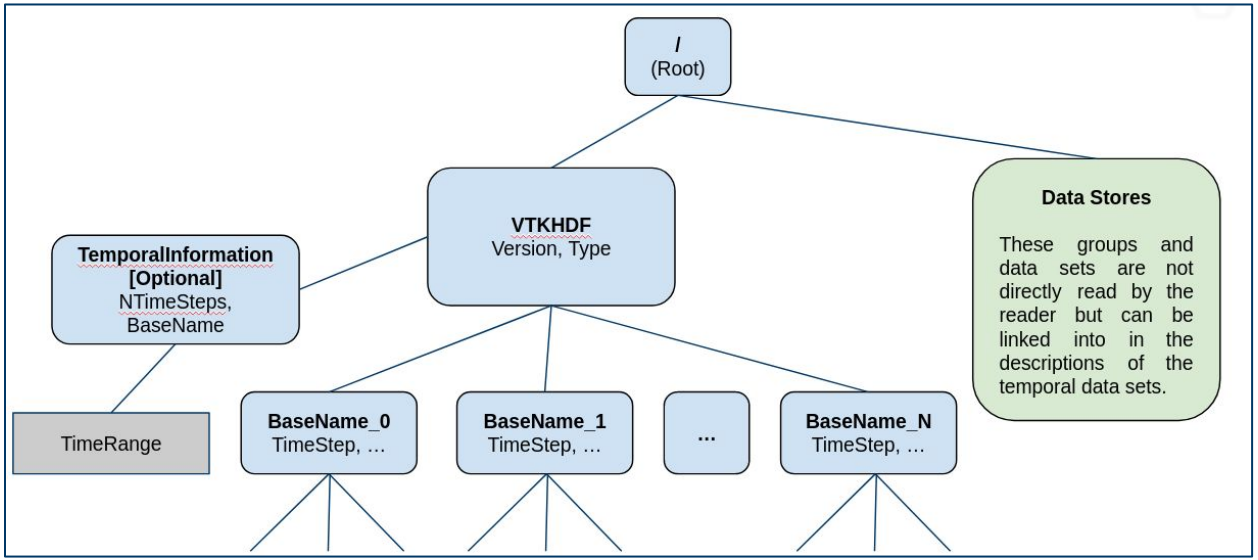
ParaView's development drivers and feedback loops: Process

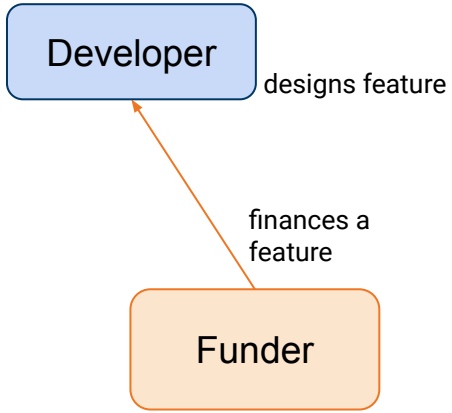
ParaView's development drivers and feedback loops: Case Study

Initial Design:

Developer



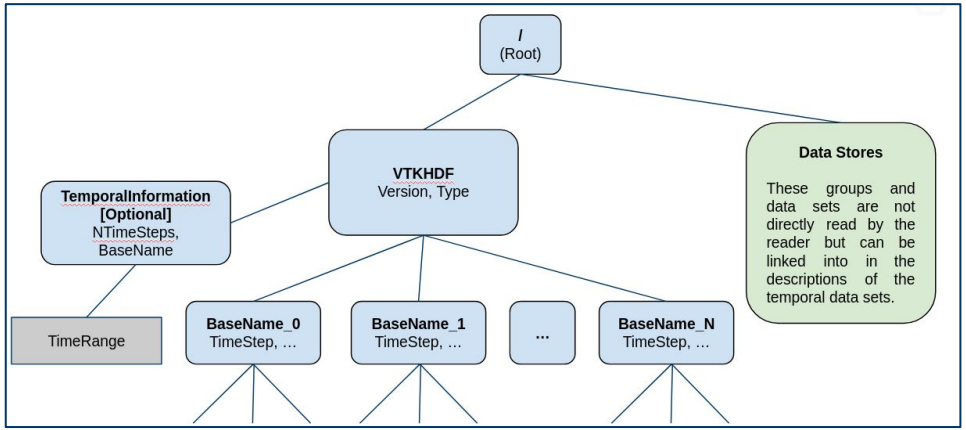
ParaView's development drivers and feedback loops: Process



ParaView's development drivers and feedback loops: Case Study

Initial Design:

Developer



Design Review Conclusions:

- Too much meta-data in file which might hurt parallel IO performance

Domain Expert

Product Owner

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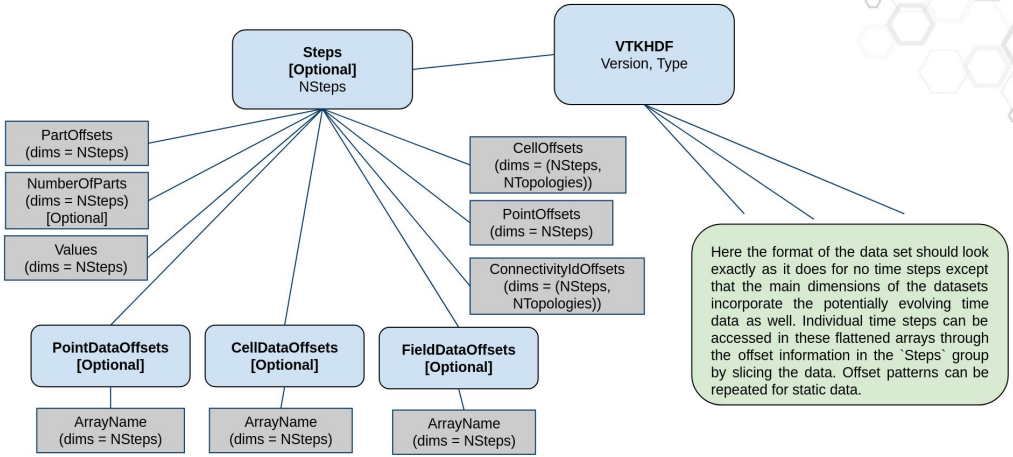
ParaView's development drivers and feedback loops: Case Study

Iterated Design



✅ Developer

✅ Domain Expert

✅ Product Owner

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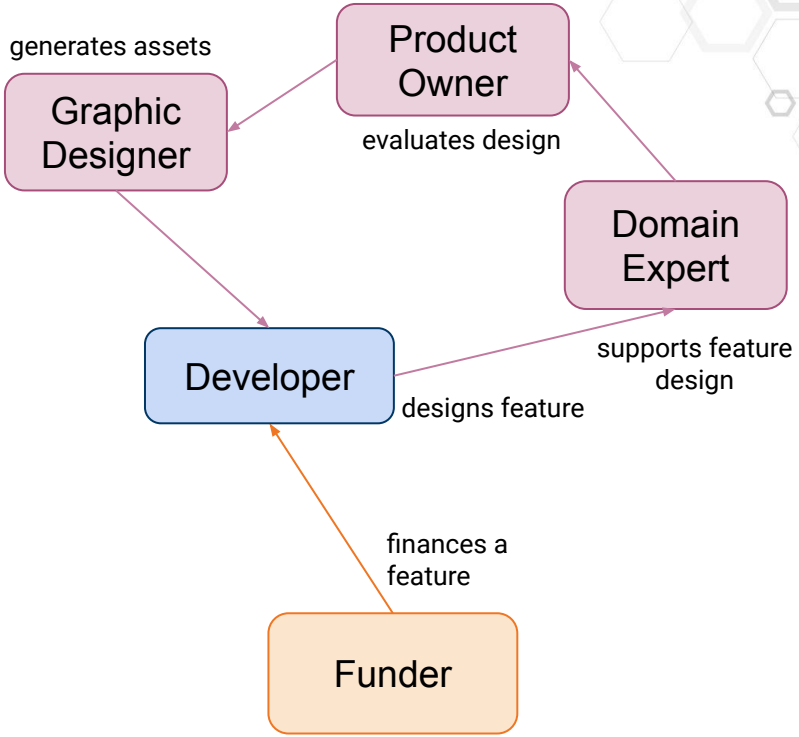
ParaView's development drivers and feedback loops: Process

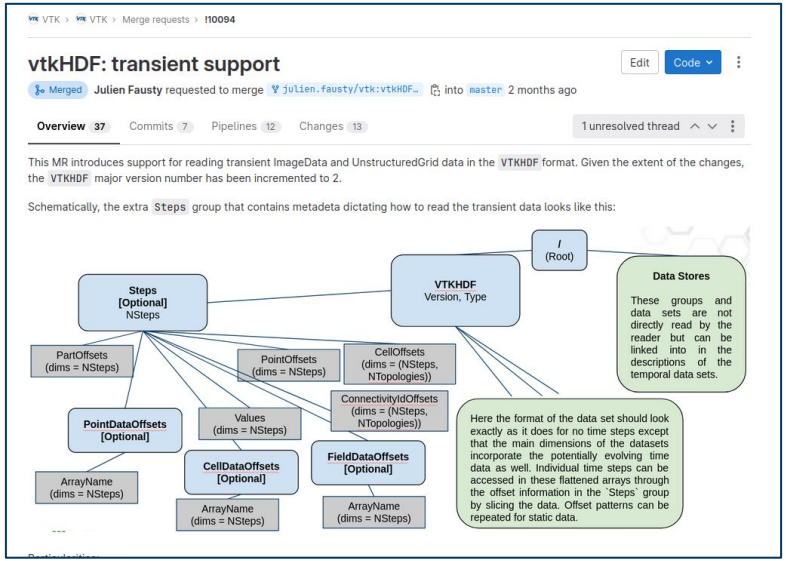


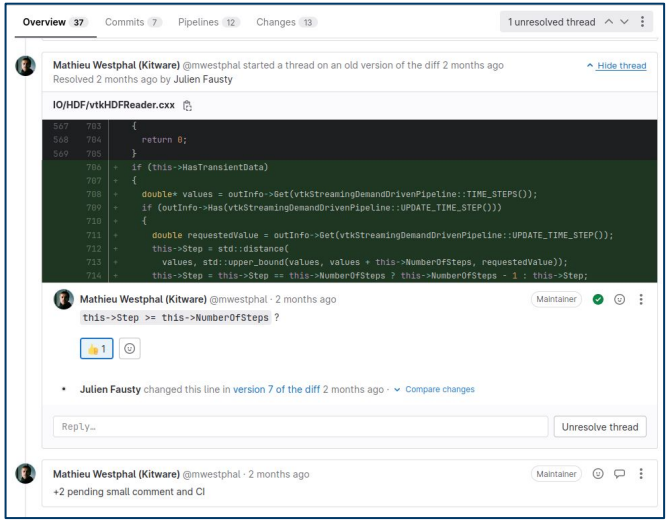
ParaView's development drivers and feedback loops: Case Study

Implementation and Merge Request:

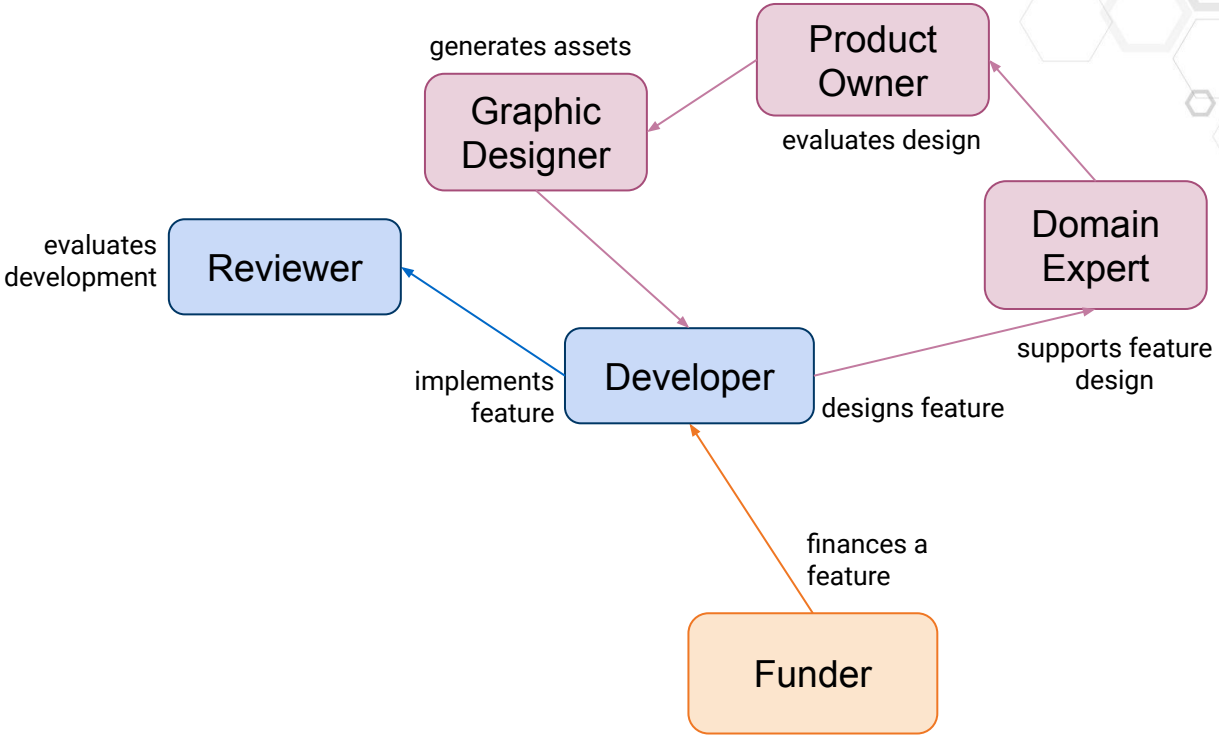
Developer

Reviewer





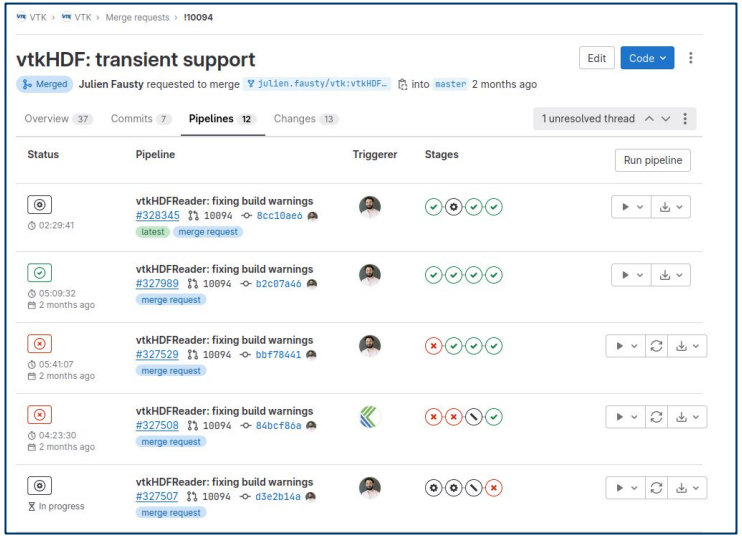
ParaView's development drivers and feedback loops: Process

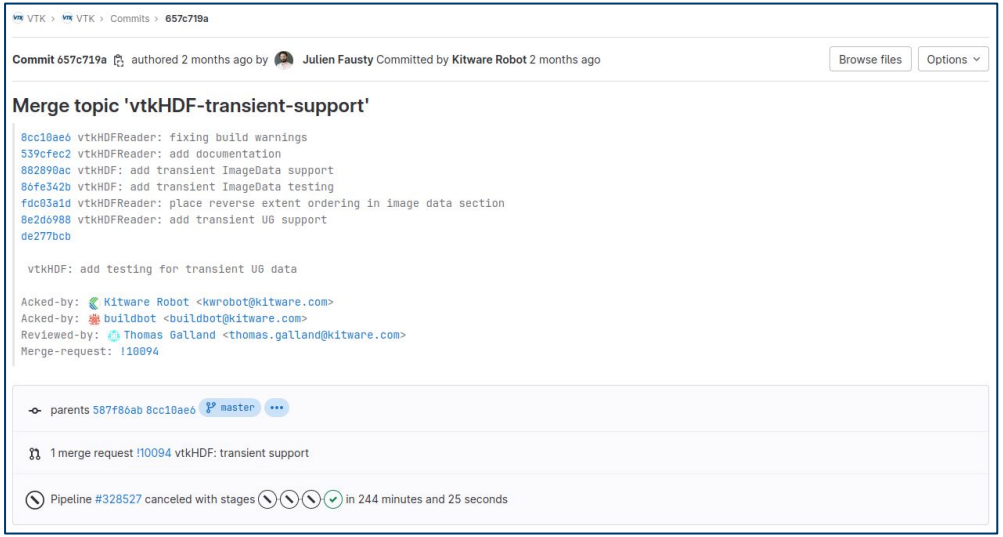


ParaView's development drivers and feedback loops: Case Study

Merging and Continuous Integration

DevOps





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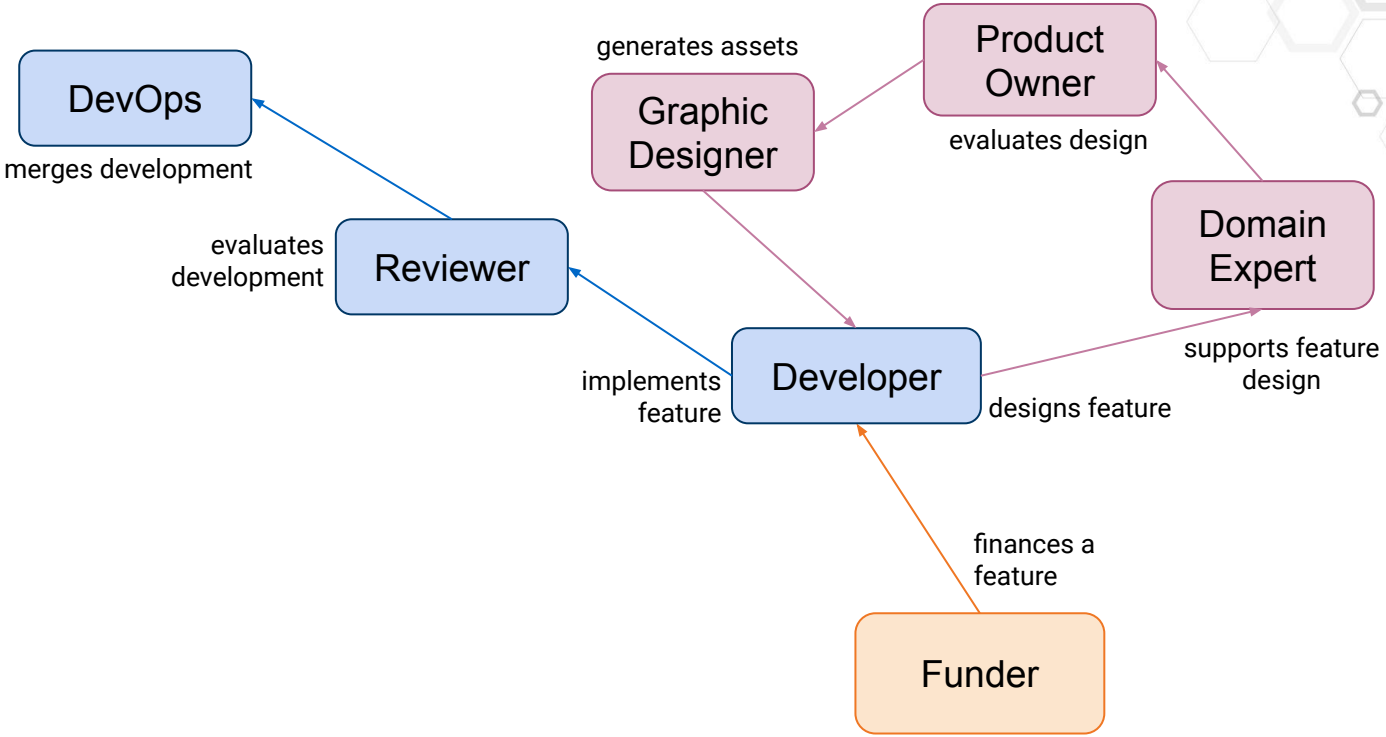
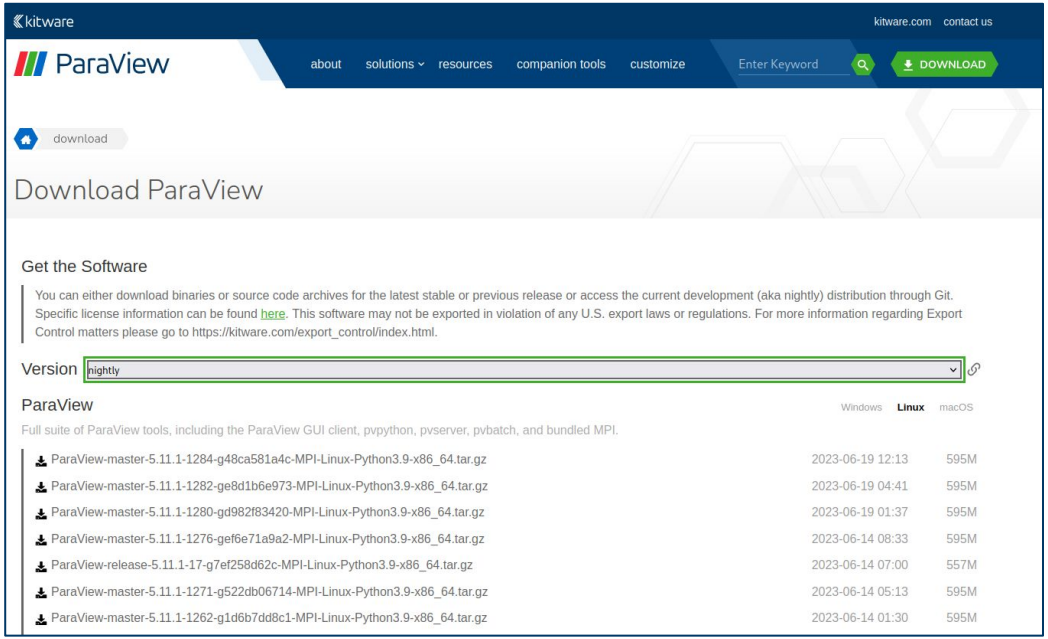
ParaView's development drivers and feedback loops: Process



ParaView's development drivers and feedback loops: Case Study

Deployment

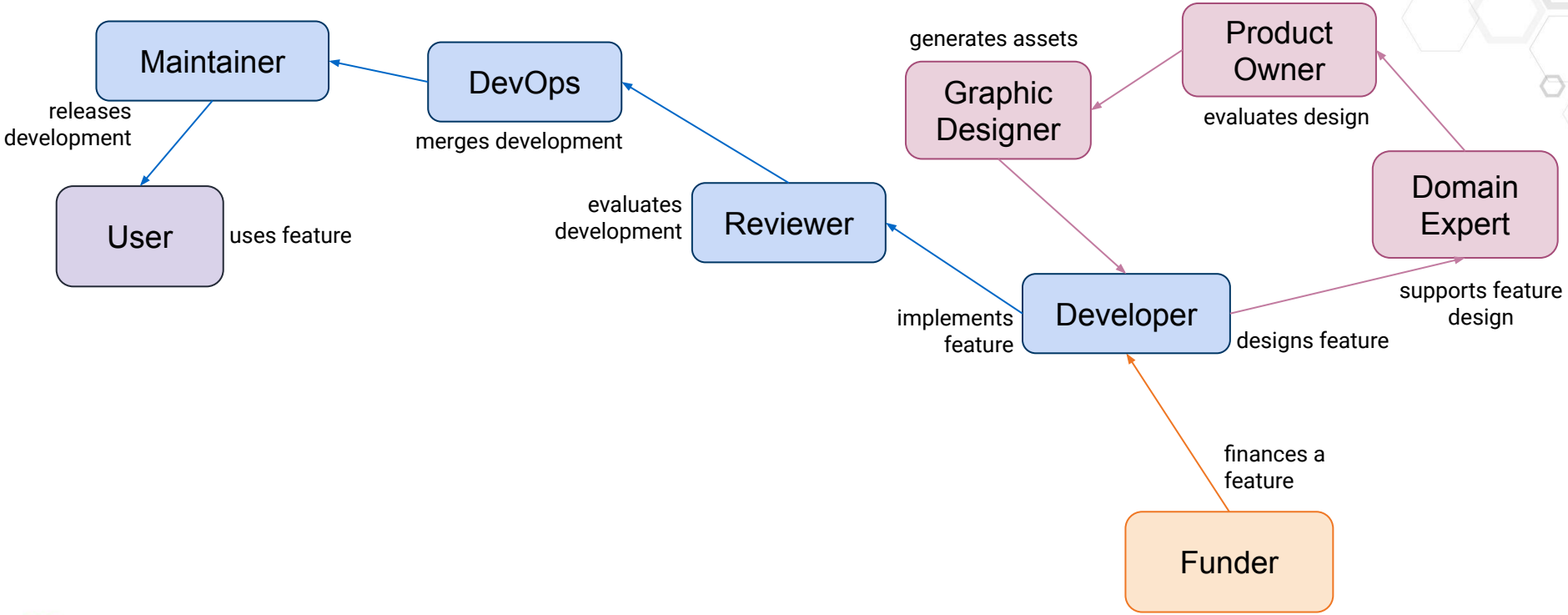


Maintainer

DevOps

https://www.paraview.org/download/

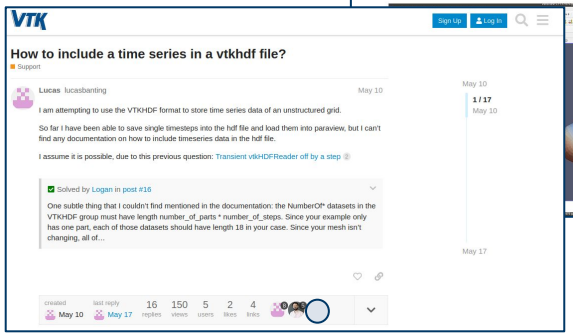
ParaView's development drivers and feedback loops: Process

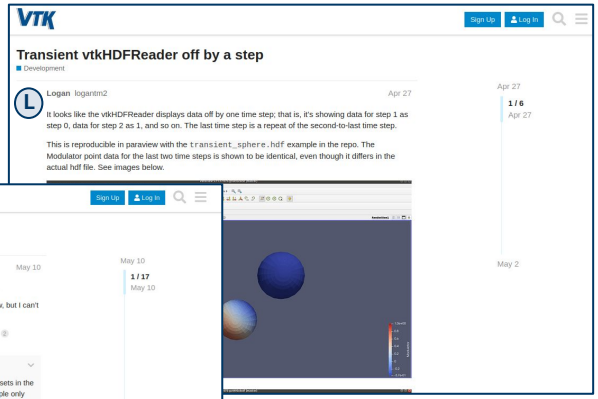


ParaView's development drivers and feedback loops: Case Study

Real User Feedback

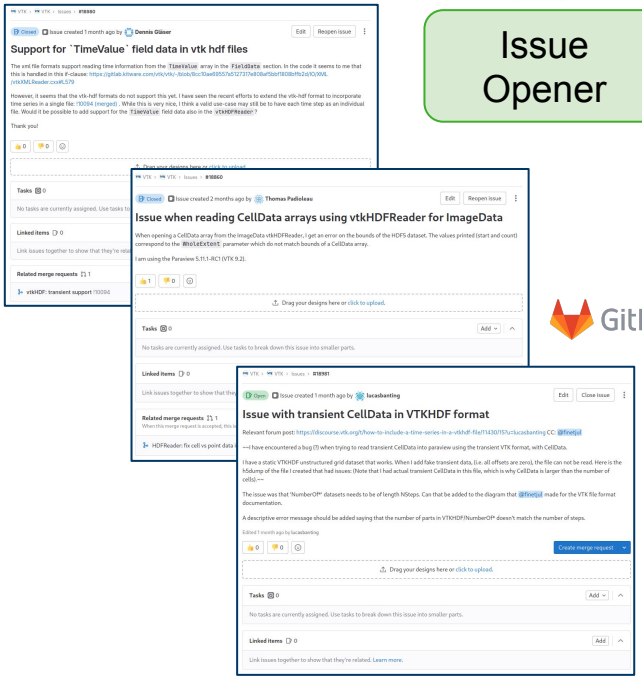
Forum User





Community Support

Issue Opener



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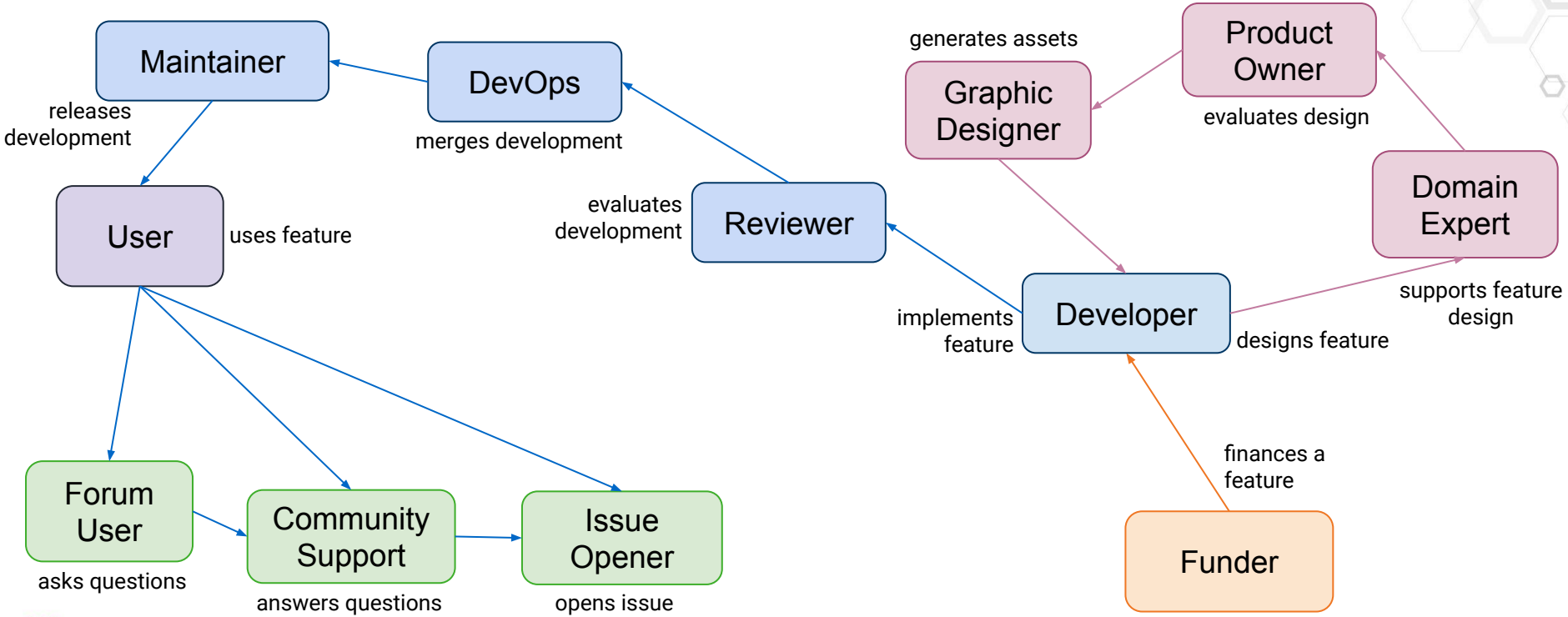
Discourse

ParaView's development drivers and feedback loops



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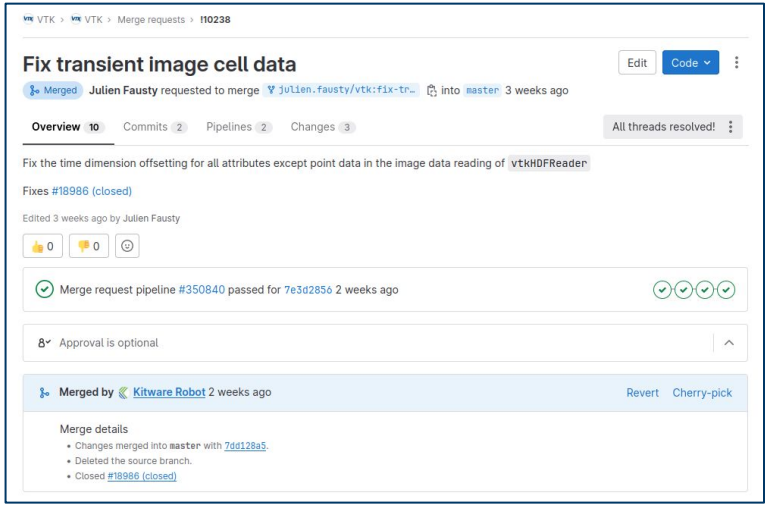
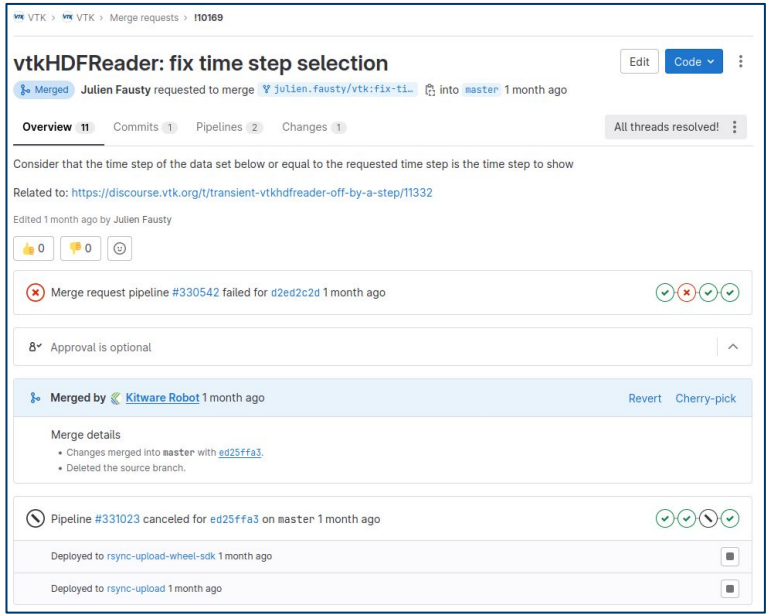
ParaView's development drivers and feedback loops: Case Study

Bug Fixing:

Developer





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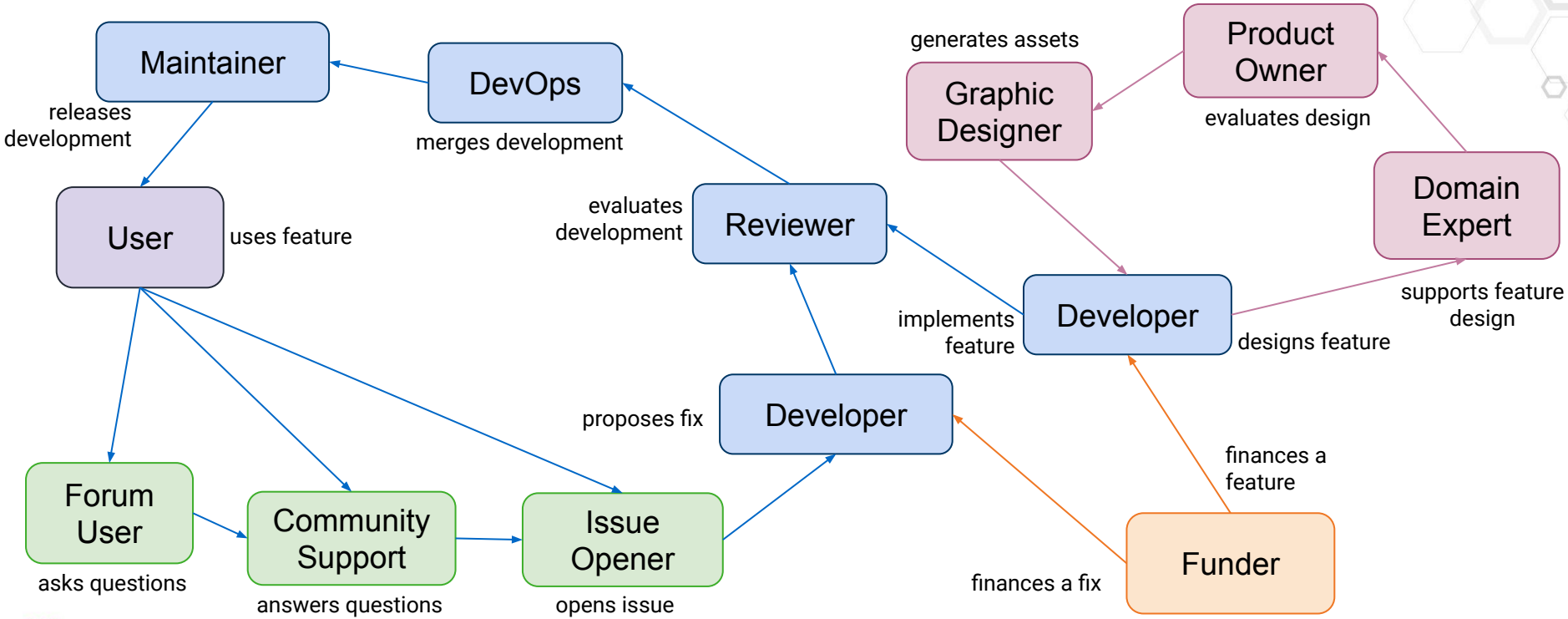
ParaView's development drivers and feedback loops



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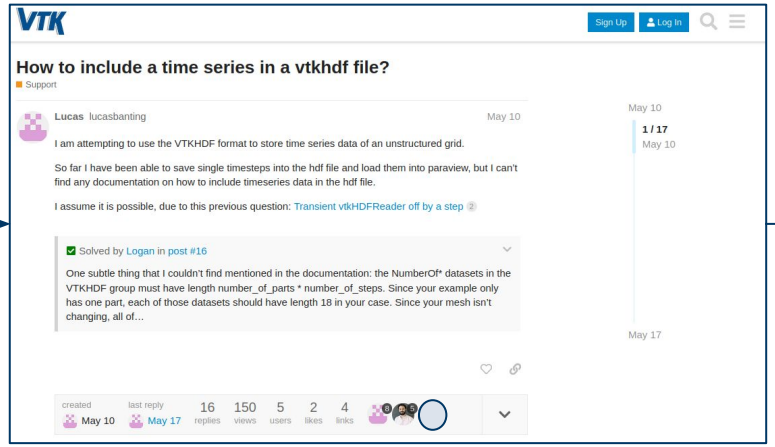
Role transitioning in the ParaView eco-system

Theory and Practice

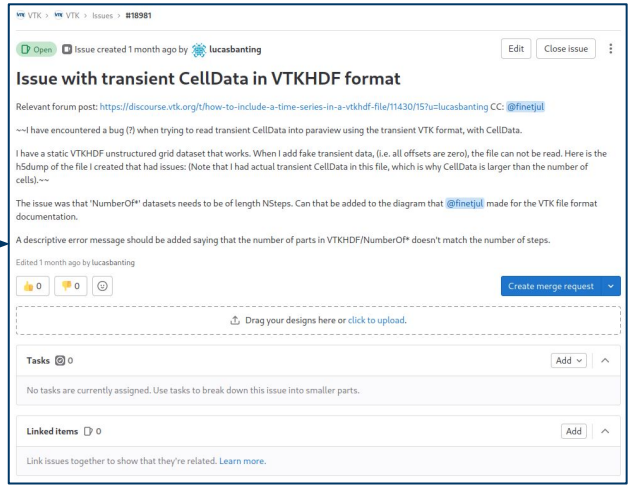
Role transitioning in the ParaView eco-system: Case-study

User



Forum User

Discourse



Issue Opener

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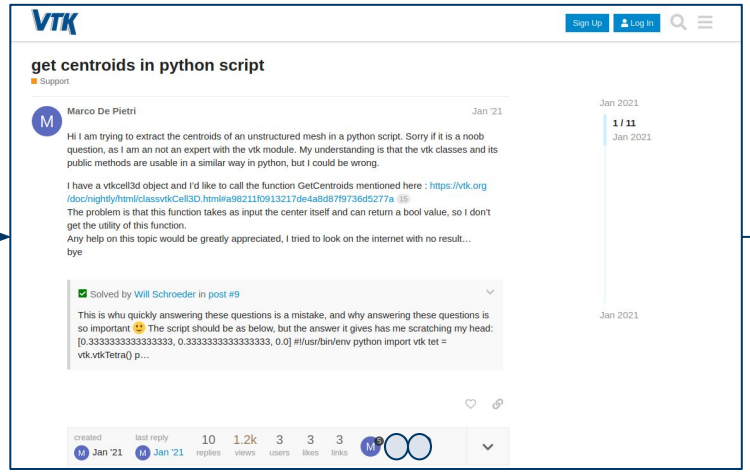
Role transitioning in the ParaView eco-system: Case-study

User



Scripter

Forum User

Discourse

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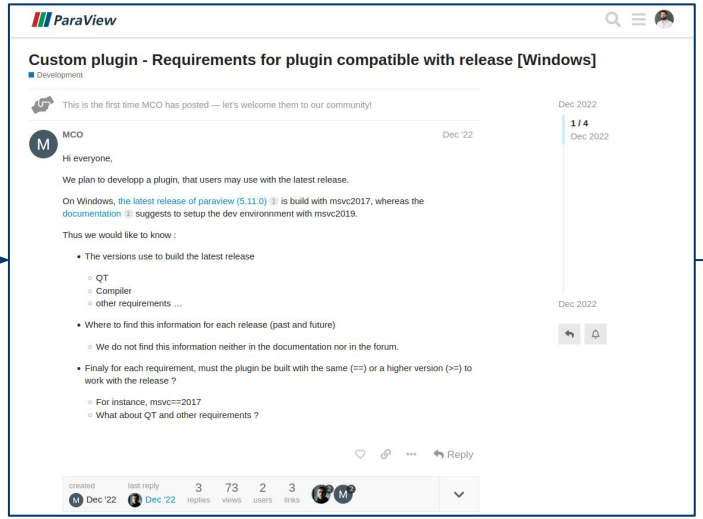
Role transitioning in the ParaView eco-system: Case-study

User



Plugin Maintainer

Forum User

Discourse

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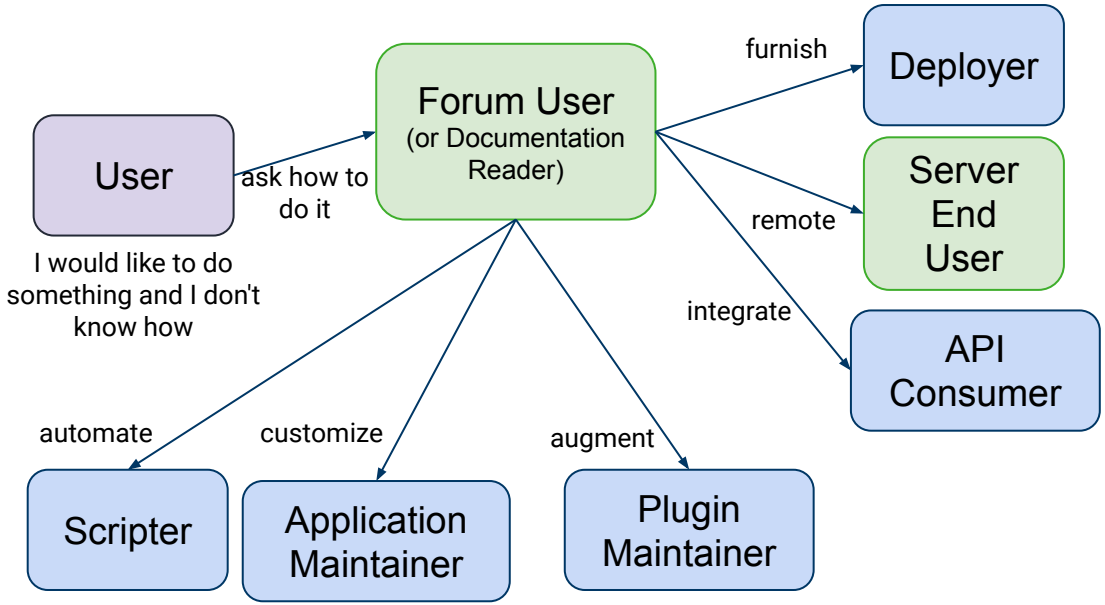
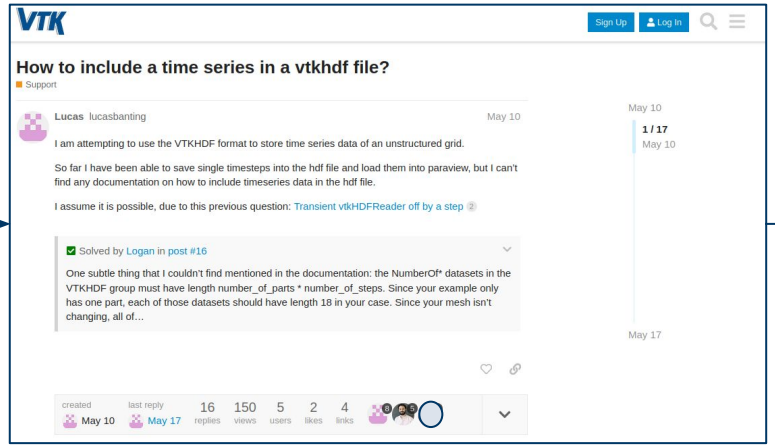
Role transitioning in the ParaView eco-system: User-upskilling



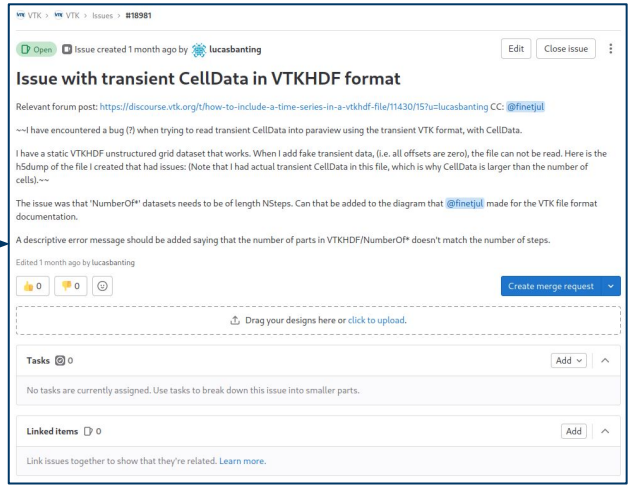
Role transitioning in the ParaView eco-system: Case-study

User



Forum User

Discourse



Issue Opener

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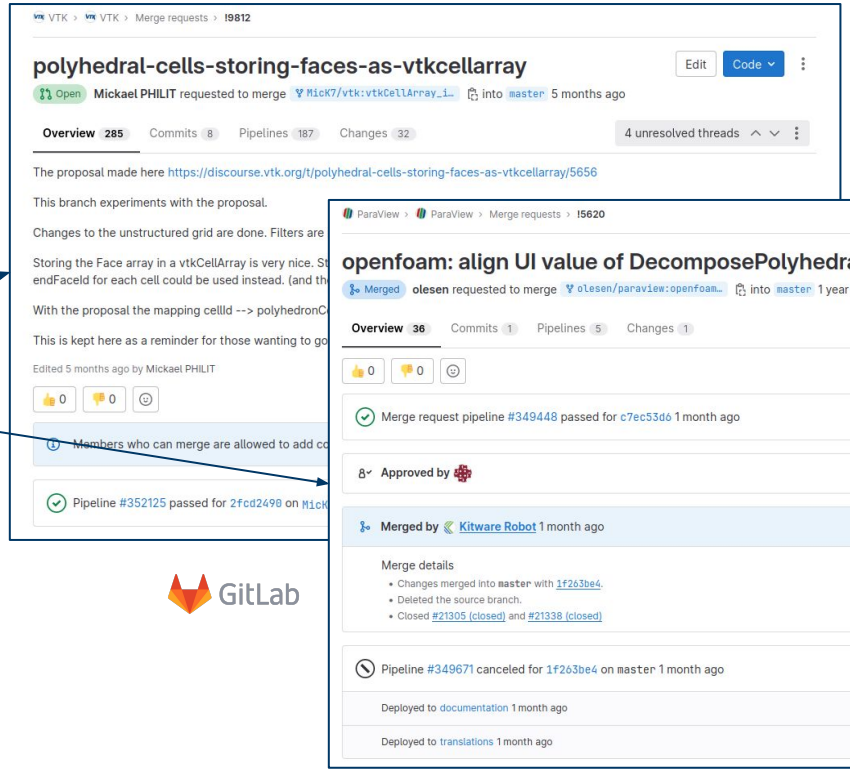
Role transitioning in the ParaView eco-system: Case-study

User

Developer



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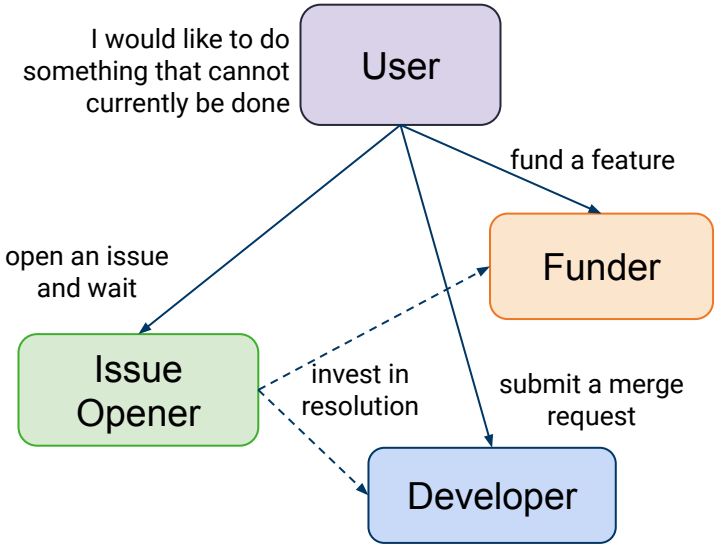
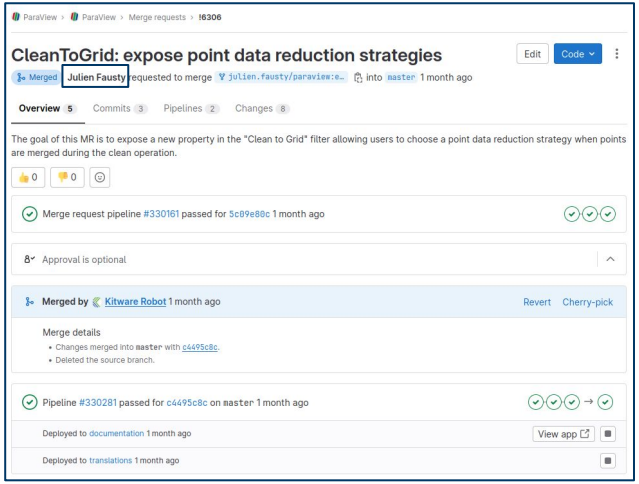
Role transitioning in the ParaView eco-system: User-Contributor transition

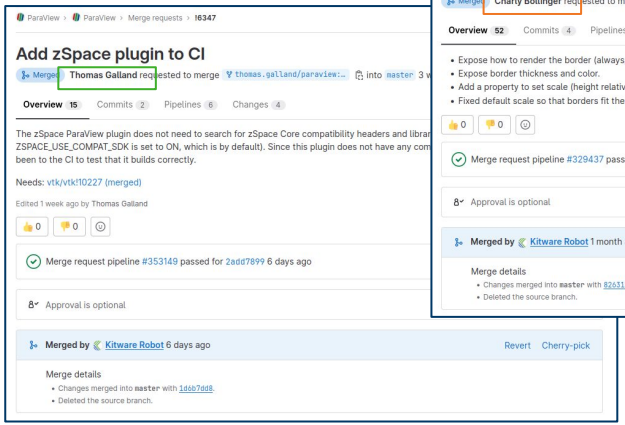


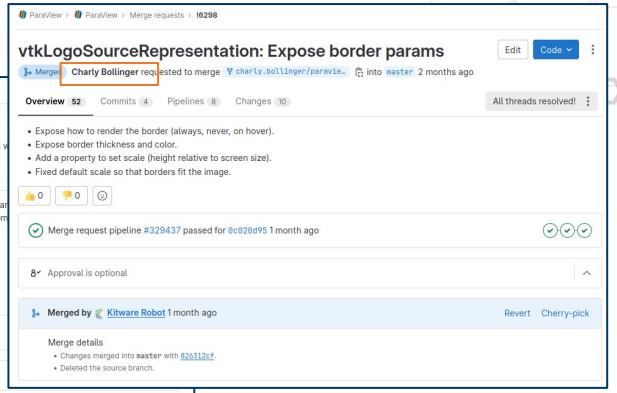
Role transitioning in the ParaView eco-system: Case-study

Developer

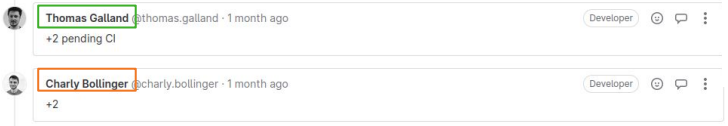
Reviewer

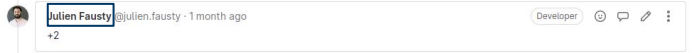






GitLab





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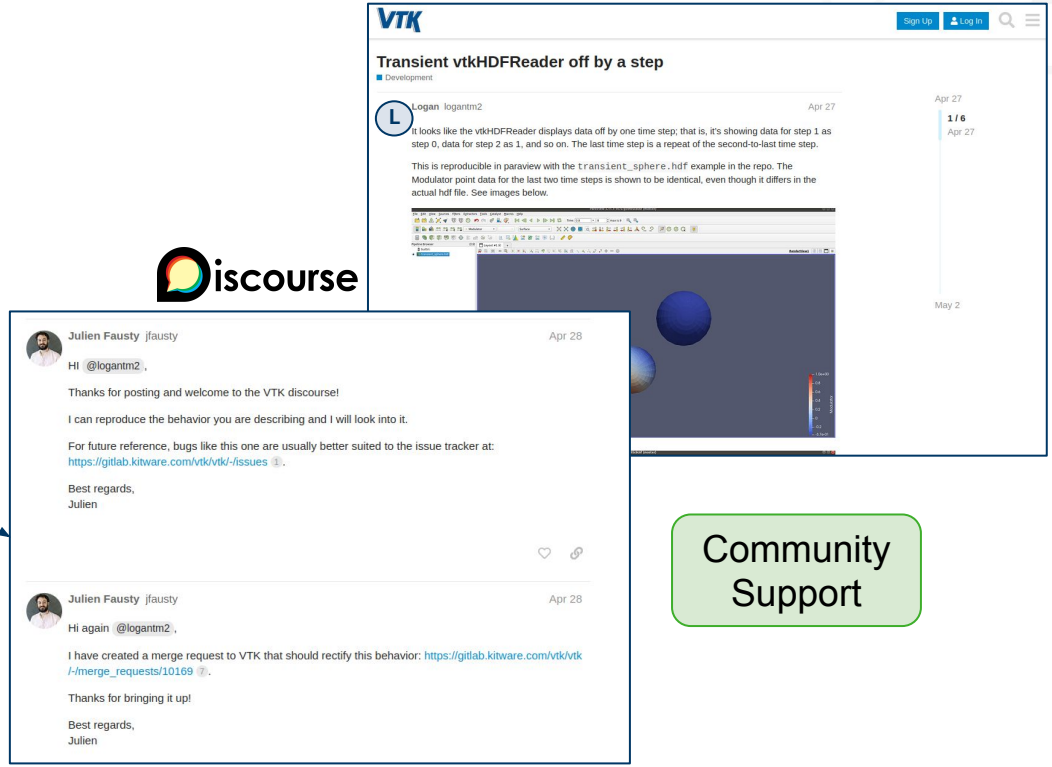
Role transitioning in the ParaView eco-system: Case-study

Developer



Community Support

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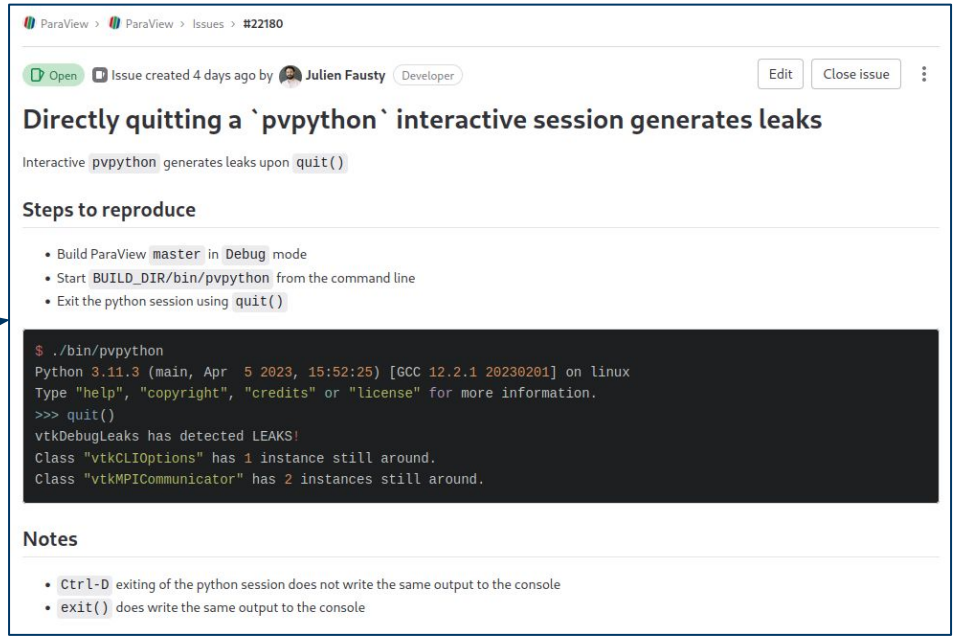
Role transitioning in the ParaView eco-system: Case-study

Developer



Issue Opener

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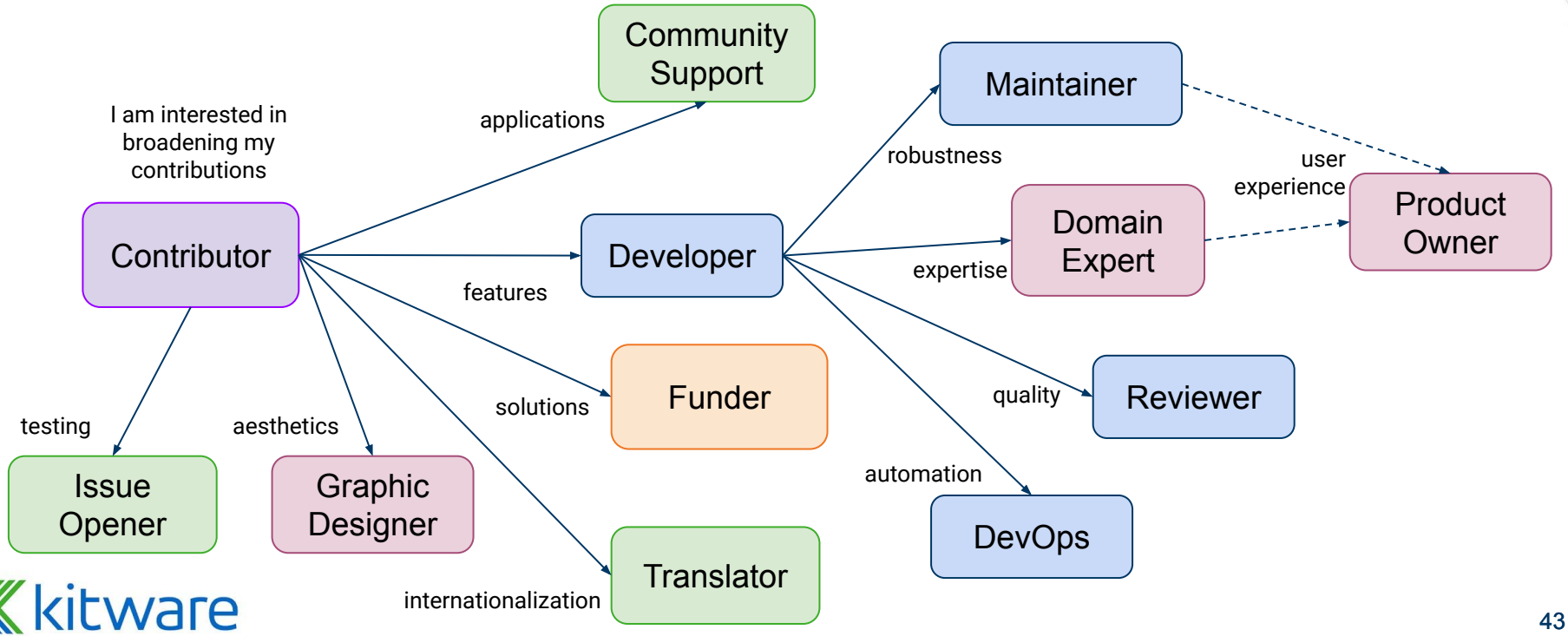
Role transitioning in the ParaView eco-system: Contributor-upskilling



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The HPC Scientific Community

and final comments

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The particularities of serving a community of scientists

- **Innovative:** always pushing the boundaries of the tools it uses.
- **Curious:** to know how things work in the background.
- **Open:** to technical discussions and collaborations.
- **Diverse:** a variety of types of problems as well as cultures.

Fosters a ParaView community with the following values:

- **Communication**: the needs of the community is the driver for change
- **Open**: all development happens in the public domain favoring rigor and honesty
- **Efficient**: every development resource counts

- **DIY:** likely to use home grown solutions instead of industry standards.
- **KPIs:** indicators are skewed towards final results and not tooling.
- **Time-Crunched:** many interesting things to do and not enough time to do them all.

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The challenges of HPC open-source tools

Rank	System	Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
1	**Frontier** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE DOE/SC/Oak Ridge National Laboratory United States	8,699,904	1,194.00	1,679.82	22,703
2	**Supercomputer Fugaku** - Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D, Fujitsu RIKEN Center for Computational Science Japan	7,630,848	442.01	537.21	29,899
3	**LUMI** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE EuroHPC/CSC Finland	2,220,288	309.10	428.70	6,016
4	**Leonardo** - BullSequana XH2000, Xeon Platinum 8358 32C 2.6GHz, NVIDIA A100 SXM4 64 GB, Quad-rail NVIDIA HDR100 Infiniband, Atos EuroHPC/CINECA Italy	1,824,768	238.70	304.47	7,404
5	**Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband, IBM DOE/SC/Oak Ridge National Laboratory United States	2,414,592	148.60	200.79	10,096

~ 600 million $

https://en.wikipedia.org/wiki/Frontier_(supercomputer)

~ 1 billion $

(total project cost)

https://en.wikipedia.org/wiki/Fugaku_(supercomputer)

~ 144.5 million €

https://en.wikipedia.org/wiki/LUMI

~ 240 million €

https://en.wikipedia.org/wiki/Leonardo_(supercomputer)

~ 325 million $

(with Sierra #6)

https://en.wikipedia.org/wiki/Summit_(supercomputer)

- **Access:** target architectures are more difficult / expensive to access and test on.
- **Heterogeneity:** no "one size fits all" for HPC machines or even within a single HPC machine with heterogeneous hardware.

Solution: rely on **users** to test in HPC settings and collaborate to improve support.

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https://www.top500.org/lists/top500/2023/06/

Some conclusions and outlook

Today, ParaView owes much of its success to its community being:

- **Diverse:** academic and industrial on an international scale
- **Innovative:** constantly pushing the boundaries
- **Open:** to transitioning roles and becoming more active
- **User Oriented:** seeing as every member is also a user.

Outlook

- Opportunities around adapting software for the exascale
- Recognition of open-source projects as rigorous frameworks for development
- Good synergy between reproducible science and open-source frameworks with large communities

ParaView

Take Part in the First ParaView User Day Europe!

Lyon, France - September 19th, 2023

- Inspiring keynotes
- Lightning talks by users
- Kitware one-to-one hands-on sessions
- Demo space
- ParaView dinner (optional)

Join the experience and present!

We understand the value of your expertise, if you want to share with the community, you can submit a presentation title and summary to present during the event.

kitware cea TotalEnergies

More Info: https://www.kitware.eu/paraview-user-day-europe-2023/

Thank you for your attention and looking forward to your contributions ;) !

Questions?

Or/and contact us at kitware@kitware.fr or julien.fausty@kitware.com

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