PPPL PRINCETON PLASMA PHYSICS LABORATORY

TRANSP

TRANSP: progress and plans

presented on behalf of the TRANSP development group:
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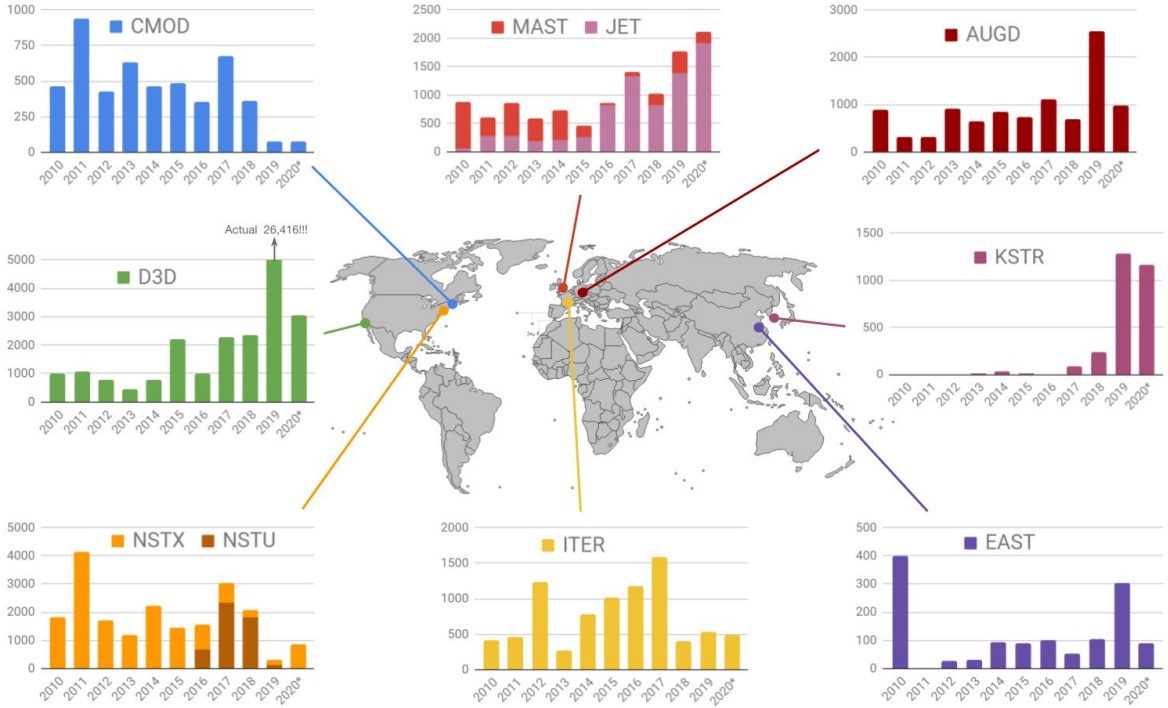
TRANSP has been serving the plasma physics community for almost 40 years

TRANSP usage: over 100k simulations performed since 2010



TRANSP also used for: FNSF, HI2A/HL2M, LTX, SPRC, STEP, TCV, and TFTR

number of users expected to increase

- 50% in the next year
- double in 2 years

as of today ratio user:developer is 50:1

20 years ago 5:1

=> the ‘old way’ no longer works

In the spring of 2018 we decided to make a shift

- Needed a better streamlined procedure for release
  - => act on this immediately
- Needed to upgrade the physics in the code in a more modular way
  - => working on a new architecture that enable this
- Needed to involve the community more
  - actively working with physicists to increase engagement in development

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- Needed a better streamlined procedure for release
  - => act on this immediately
  - backward compatibility is an excuse, software has a finite lifetime
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Now (almost) fully automated release under CI/CD

Main developers: Jai Sachdev and Laszlo Glant

- 2018: moved from SVN to GIT and registered the code with OSTI:

  `doi:10.11578/dc.20180627.4.`

  and started procedure for export control and licensing, SQAP, controlled release of tshare and pshare => completed
- 2019: initiated CI/CD, moved regression test suite under CI => completed
- end of 2019: TRANSP the only code at PPPL with approved EAR99 exemption, under SQAP and the only code in Category 1
  - Implications for third-party codes => now extracting and linking as libraries
- 2021: completed container-based version, exploring cloud service
  - expand pool of users and enable use from our colleagues in China.
  - a container-based version is the top request from a recent users survey
- 2022 (upcoming): a new architecture, a modern code, new reference paper

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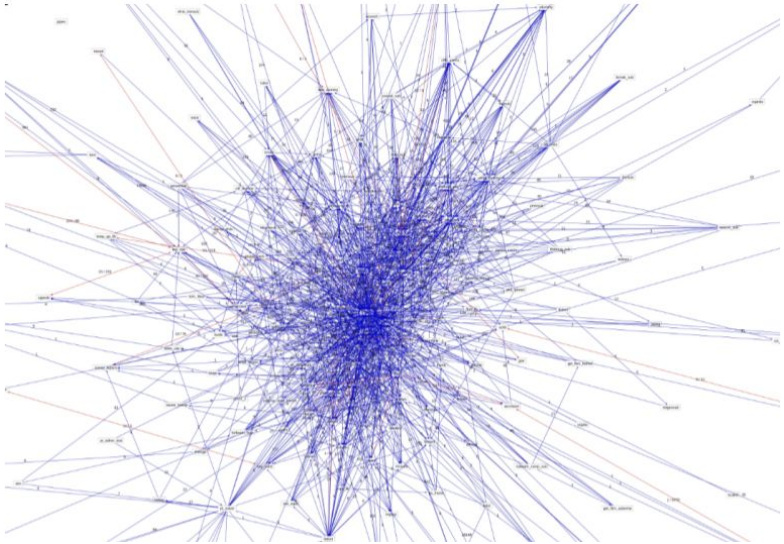
=> both required a major refactoring, modernization and modularization

The path to a community WDM required redesigning the architecture

this graph is the reason why you get a 'NO' when you ask 'can you couple my xyz model in TRANSP?'



dependency plot generated by Jai Sachdev using the UNDERSTAND® software

- almost 2M lines of code, a huge common block of ~6000 variables
- lot of deprecated code
- many legacy script (< F77)
- external codes imported in the source

=> Invested in a software tool to map dependencies

=> Started 'cleaning up the code'

=> postponed any major physics upgrade

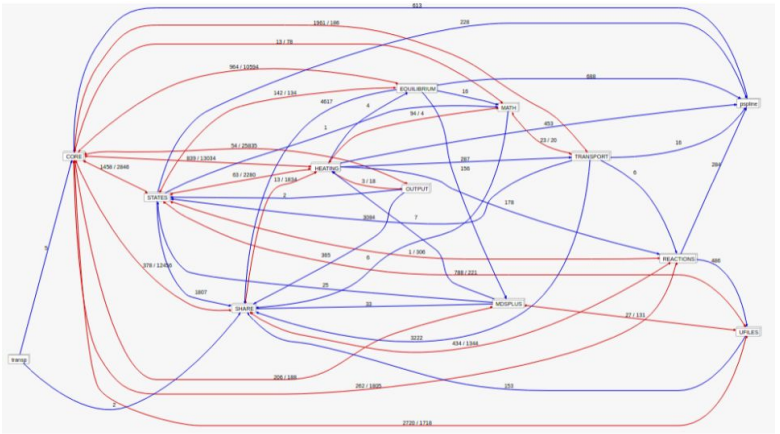
After one year some of the critical 'bundle' was removed

dependency plot generated by Jai Sachdev using the UNDERSTAND® software

- still over 5400 variables in the common
- still external codes imported in the source
- but all dependencies traced, now planning forward.

what you get: TRANSP runs are now on average 2x faster

Here an experiment on re-organizing the directories. TRANSP is getting ready to be put at the core of a WDM effort



What comes next

- keep cleaning ...
- all physics modules are being extracted and linked as pre-compiled libraries
- the architecture is being re-designed to enable coupling of physics and engineering for WDM
  - IMAS-IDS compatibility is our priority => this is the future
  - generalize H&CD and transport interface, for coupling of ANY code
- active effort on developing/upgrading synthetic diagnostics
  - for model validation and for control applications

  if you are a diagnostics expert and wish to contribute, please get in touch.
- enabling inclusion of engineering components (PFC, RF antennas, etc.)

  critical for the FPP mission

We have projects for any wish … just get in touch

What about the physics upgrades?

Short-term plans support immediate needs of the domestic and international collaborations

- Predictive particle transport (A. Pankin with DIII-D group)
  - isotopic experiments on DIII-D, DT campaign on JET, ITER and FPP design
  - requires redesign of the predictive workflow in pt-solver
- RF-NBI synergy (M. Gorelenkova, with RF group and theory)
  - supports NSTX-U restart, JET, ASDEX-U, EAST, all experiments with IC+NBI, ITER
- Fast ion transport (J. Breslau with EP SciDAC)
  - supports all experiments, ITER and FPP
  - coupling of MHD stability codes: GPEC/DCON (with LLNL)
  - coupling of AEs stability codes: FAR3D (with ORNL)
  - kick model and RBQ
- Core-edge coupling (G. Perumpilly, with X. Zhang)
  - supports all experiments, ITER and FPP
  - opens new avenues for RF modeling and edge/divertor modeling

TRANSP is evolving to support the fusion mission

but we need your help !

- you will be able to contribute to new physics modules
- 'coupling' physics to TRANSP will be different
  - we are going to provide you with an interface that is general and agnostic
  - your module MUST be compatible with IMAS
  - you will run TRANSP+your favorite module, which won't be part of TRANSP
- help us putting together a better documentation
  - share your how-tos, work with us on preparing tutorials
- we ask that you submit all your questions and issues to TRANSPHub

  https://github.com/PrincetonUniversity/TRANSPhub.git