

Software and Computer Training

Tim Scanlon (UCL)

3rd November 2021

Training

- ❖ Software/Computing expertise vital for future of HEP programmes
 - Effective training in this area essential to future of field
 - Enable and improve our research programmes
 - Can also enhance impact/industry engagement

- ❖ Currently training offerings in the UK somewhat ad-hoc/disjointed
 - Would be good to implement a more coherent and complete UK-wide S&C training programme
 - In close collaboration with international training initiatives
 - UK-focussed training to build strong cross-experimental cohort of UK S&C experts, focus on UK specific needs and build capacity
 - Could Swift-HEP act as a catalyst for this?

- ❖ Overview
 - UK S&C training landscape
 - S&C training internationally
 - Future of UK training
 - Swift-HEP training

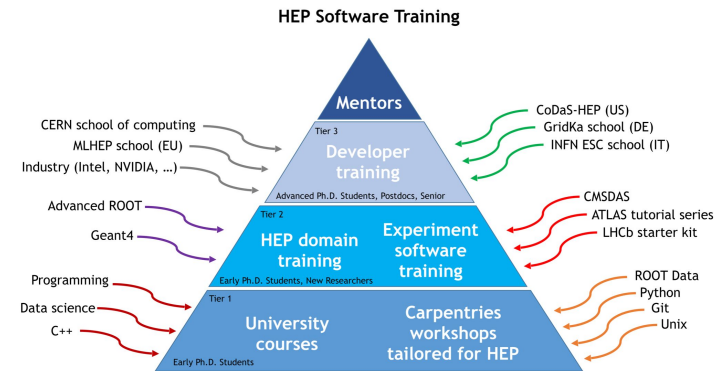
UK S&C Training Landscape

- ❖ Landscape across the UK somewhat ad-hoc and disjointed
 - Undergraduate
 - Programming usually taught (but not always)
 - Taught postgraduate
 - Physics based scientific computing MSc courses starting to become popular
 - Early stage PhD students
 - Training provided by universities and experiments
 - Variations depending on University/experiment
 - Software carpentries
 - Usually only focuses on a few basic skills
 - Swift-HEP
 - Only a relatively small fund provided for training
 - STFC Data Science focussed summer school
 - Curriculum varies every year and mostly for CDT students
 - Industry
 - Occasional courses provided by Partners (e.g. FPGAs by Intel)
 - International community-wide training courses
 - HSF, First-HEP, SIDIS, CERN and various Summer Schools
- ❖ A more coherent and accessible UK-based training programme seems desirable

S&C Training Internationally

❖ Several international endeavours in this area

- HSF: <https://hepsoftwarefoundation.org/workinggroups/training.html>
- IRIS-HEP: <https://iris-hep.org/ssc.html>
- First-hep: <https://first-hep.org/about/>
- SIDIS: <https://sidis.web.cern.ch>
- Software carpentry: <https://software-carpentry.org>



❖ All have a similar aim: help the research community provide training in the computing skills needed for researchers to produce high quality and sustainable software

- Introduce a common HEP software curriculum and collaborative framework
 - Basic programming skills (e.g. Python, C++)
 - Basic software engineering skills (e.g. Unix, git/GitHub/GitLab, CI)
 - Skills in the core software (e.g. Root)
 - More advanced developer training (e.g. parallel programming, machine learning, efficient software implementations)

❖ Large degree of collaboration between all these different programmes

- Provide a more coherent and unified training programme within a country
- Build strong cohorts of S&C experts

Future of Training in UK?

- Current S&C training offerings in UK could implement a similar endeavour
 - A platform for wider upskilling of field?
 - PhDs, PDRAs, core staff and academics
 - Build upon and expand existing training where possible (CDT etc.)
 - Implement a UK-wide coherent/integrated training programme
- Such a plan for the UK could include:
 - Set of S&C standards for UG courses across UK (in conjunction with the IoP)
 - Recommended S&C curriculum for 1st year experimental HEP PhD students
 - Menu of regular UK workshops/courses (carpentry style?)
 - Collaborate with HSF, IRIS-HEP, HEP-FIRST and others
 - Build up capacity/contingent of UK people to deliver/create material
 - Catering to all levels of seniority and expertise
 - More advanced courses where specific skill-sets are needed:
 - Software engineering, firmware engineering, recent language developments (C++/Python), programming for heterogeneous architectures, parallel/optimised scientific software, machine learning, tools for software development/testing/profiling,
 - Industry led workshops
 - Exploiting the latest hardware developments: FPGAs, GPUs, CPUs, intelligent networks working with Intel, NVidia, ARM and Mellanox

Swift-HEP Training: Proposal

- ❖ Awarded £30k over three years
 - Need to consider how to make best use of this
 - Use as a catalyst to build UK-wide training offering?
- ❖ We suggested several training options in the proposal
 - Software Carpentry courses
 - Advanced courses
 - Software engineering, firmware engineering, recent language developments (C++/Python), programming for heterogeneous architectures, parallel/optimised scientific software, machine learning and tools for software development/testing/profiling....
 - Technology briefings
 - Exploiting the latest hardware developments (FPGAs, GPUs, CPUs, intelligent networks)
 - STFC DIS Summer School
 - Held annually
 - Leadership training
 - Industry Group projects
 - Industry placements
- ❖ Present some thoughts for discussion on the next two slides

Swift-HEP Training: Next Steps 1

- ❖ UK-based in person training courses
 - **Poll community to identify training topics with most demand**
 - **Both starter and advanced courses**
 - Software Carpentry and advanced courses
 - Make use of large number of 'open source' options developed by community
 - Develop new courses to augment the HSF courses already available
 - Build-up contingent of course tutors/developers within the UK
 - Technology briefings
 - Usually provided free by industry
 - **Approach potential Partners (Intel, ARM, Nvidia etc.)**
 - **Hosted 2+ times a year at cost effective Universities/Labs**
 - Depending on what funding is provided for could cost in the range of £2k-10k
 - **Combine with Swift-HEP meetings to reduce travel costs?**
- ❖ STFC DIS Summer School
 - CDT students attend for free
 - **Ask STFC if Swift-HEP people and other PhD students can also attend for free**
- ❖ Leadership courses
 - **Identify best RS or University based leadership courses for Swift-HEP RAs**

Swift-HEP Training: Next Steps 2

- ❖ **Industry Group projects**
 - Run annual scheme at UCL for PhD/RAs
 - No cost and can be run remotely
 - **Trail extending UCL programme to incorporate Swift-HEP people this year?**
- ❖ **Industry placements**
 - Too expensive to fund from available budget
 - Fund from either Impact Acceleration Funds or industry
 - **Start to identify suitable partners and timeframes for Swift-HEP RAs**
- ❖ **Create Swift-HEP training website to highlight and organise training opportunities**
- ❖ **Discussion**
 - Other ideas for training initiatives?
 - How ambitious should we be with the UK-based training courses?
 - Trial approaches at lower level in first year and ramp up if they prove successful?

PPTAP: Software and Computing Roadmap

*Neil Chue Hong (Edinburgh)
and **Tim Scanlon (UCL)***

3rd November 2011

Rationale

- ❖ International community is currently putting together R&D roadmaps in the **detector and accelerator areas**
 - **Software and computing (S&C)** is not directly included (yet)
 - UK is providing significant input into that process
- ❖ STFC launched the PPTAP process to create a UK R&D roadmap and to feed into the above process
 - PPTAP = Particle Physics Technology Advisory Panel
 - Previously no 'PP R&D strategy' in STFC and no way of developing one
 - **S&C is included as one of the three key pillars in the STFC roadmap**
- ❖ Launched a process to gather community input for the S&C part of the UK R&D roadmap
- ❖ An important opportunity to make the case for new funding to UKRI
 - Could have long-lasting consequences
 - Important to make strongest possible case
 - Could be a significant scientific, funding and impact opportunity

Roadmap

❖ S&C roadmap broadly focused on the following sections:

- What's been done before and other roadmaps
- Short/medium/long-term challenges, requirements and priorities
- UK's strengths and how these relate to priorities
- Synergies with other areas
- Rationale: benefits to physics and benefits to UK
- Framework of funding
- Skills, training and career development needs

❖ Content of roadmap

- Is not a detailed list of the R&D needs of the various experiments
 - Although this will be referenced/detailed in separate 'white-paper'
- Aims to pull out cross-cutting R&D needs into more general points
- Important list is inclusive and points aren't missed
- Important to note that we are not ranking R&D needs

Process

❖ As there is no European roadmap, followed a slightly different process to the detector and accelerator parts of the PPTAP roadmap

❖ Process

- Reviewed/collected **pre-existing literature**
 - Extensive amount of roadmaps/projects already
- **Discussions** with a range of S&C experts
 - Understand present/future landscape
- **Survey** to gather information from wider community
 - Collect individual input
 - Probe areas where a range of views exist
- **PPTAP S&C Workshop**
 - Collect project/experimental input
 - Forum to discuss key areas where a range of views may exist
- **Final roadmaps**
 - Input into main PPTAP report
 - Software & Computing R&D Roadmap 'White Paper'

Review of other roadmaps

- ❖ Extensive amount of literature relating to S&C R&D already produced
 - Forms bedrock of input to PPTAP S&C roadmap
 - Key repeated themes (apart from funding and better quality software)
 - Need for more Research Technical Professionals (inc. RSEs)
 - Cost-effectiveness of common solutions, improved sustainability
 - Need for continued performance improvements to support science
 - Potential impact of new technologies

Whitepapers:

- ❖ [UKRI: Science Case for UK Supercomputing](#)
- ❖ UKRI e-Infrastructure Roadmaps
 - AAI Federation, Cloud, Network, Research Data, Software and Skills, Supercomputing
- ❖ [ExCALIBUR RSE Knowledge Integration Landscape Review](#)
- ❖ STFC College of RSEs Outline case
- ❖ UKRI Infrastructure [Opportunity Report](#) and [Landscape Analysis](#)
- ❖ [RSEs State of the Nation](#)

Proposals:

- ❖ Swift-HEP
- ❖ ECHEP
- ❖ Dirac-3

Experimental:

- ❖ S&C CDRs and TDRs
- ❖ [CERN Openlab whitepaper in future ICT challenges in scientific research](#)

HSF documents:

- ❖ [HSF Roadmap](#)
- ❖ [HL-LHC Computing Review](#)
- ❖ [Software Sustainability and HEP](#) (IRIS-HEP)

Workshop

- ❖ The workshop broadly had the following structure:
 - Link: <https://indico.stfc.ac.uk/event/331/>
 - **Day 1:** Experiments, infrastructure and external experts provide a overview of the S&C R&D requirements, challenges and synergies.
 - Focussed on collecting input and establishing overview
 - **Day 2:** More detailed discussion of **a selection of cross-cutting points**
 - Key areas like training, career prospects and research technical professionals
 - Detailed discussions on points raised during Monday and identified from survey/previous discussions
- ❖ Google document used to collect feedback during discussions
 - <https://bit.ly/PPTAPSoftwareComputingNotes>
- ❖ A lot of extremely useful discussion and input from the discussion
 - Collated it into a suitable high-level form for the PPTAP document

Final PPTAP Report

- ❖ Input from detectors, accelerators and S&C provided in September/October
 - Core team working on first complete draft
 - Timeline for final report has been extended
 - Likely further internal review and discussions prior to community-wide feedback
- ❖ Collected a lot of very useful information over the past year
 - Collating all of this into a more detailed S&C R&D roadmap 'white-paper'
 - Including more detailed/specific recommendations
 - Let us know if you would like to help write this document!
- ❖ Given time limitations will aim to summarise high-level points passed to PPTAP drafting group in next two slides
 - Very much focuses on **enabling steps** rather than distinct R&D projects

High level PPTAP Inputs 1

- ❖ S&C R&D is one of the key pillars of all future PP programmes and is vital across all aspects of experiments
 - Significant scientific and economic opportunities from such investment
 - Need sufficient investment to ensure that initial S&C demands can be met
 - Needs to be maintained over the lifetime of the programme

- ❖ Despite significant experimental differences many cross-cutting R&D S&C areas within the field
 - UK has significant leadership in many of these areas
 - Leadership built upon previous investments and more piecemeal funding
 - Will be significantly impacted if no further investment is forthcoming

- ❖ Ensure the UK has sufficient S&C skills and expertise in the field by having:
 - Relevant UK-wide training in place for HEP researchers
 - A pool of Research Technical Professionals (RTPs) available
 - Established career pathways for RTPs to improve recruitment and retention

High level PPTAP Inputs 2

- ❖ Ensure the UK realises significant synergies from continuing to engage with international S&C efforts and by building upon UK-based initiatives, for instance:
 - HEP Software Foundation (HSF)
 - CERN openlab
 - Cross-experimental code-development projects (e.g. [ACTS](#))
 - Greater focus on promoting knowledge transfer and common projects within STFC (e.g. Swift-HEP)
- ❖ UK should keep abreast of the latest hardware/software development to ensure:
 - Code base is future-proof, avoids lock-in and is easily maintained
 - Can be easily adapted to future technological developments
 - Ensure our activities are adapted to minimise environmental impact
- ❖ Exploratory funding is available to enable responsive blue skies S&C research
 - Ensure the field scopes out and is prepared for future developments

Summary

- ❖ PPTAP process is nearing an end now
 - An important opportunity to make the case for new funding to UKRI
 - First complete draft expected soon
- ❖ Collected a lot of very useful information over the past year
 - Collating all of this into a more detailed S&C R&D roadmap 'white-paper'
 - Including more detailed recommendations
 - Let us know if you would like to help write this document!
- ❖ Provided a summary of the high-level points passed to the drafting team
 - Let me know if you think any key high-level points weren't mentioned
 - Might already be mentioned but lost in summary
 - Will provide an opportunity for wider comment on S&C points in the report once first complete draft seen

Backup

CDT Programmes

- ❖ Designed to enhance standard training with more focus on DIS skills in academia and industry
- ❖ In addition to standard HEP/Astro courses:
 - Introductory software carpentry
 - 120 hours of taught courses
 - Choices from: software engineering, HPC, computational/simulation models, machine learning, numerical optimisation, statistics
 - Industry Group projects
 - 6-month industry placements
 - Training workshops/seminars
 - Data privacy; data security; FPGAs for DIS
 - National CDT Training Event
 - STFC DIS Summer School
- ❖ Almost all opportunities open to non-CDT students
 - Seen significant 'Halo-effect'

	Activities
Year 1	<ul style="list-style-type: none"> • Taught courses • Group project • Exams • PhD project assignment • Software (SW) Carpentry • CDT Summer School <p><u>Transferable Skills</u> <i>Communication skills, Scientific writing, Media training</i></p>
Year 2	<ul style="list-style-type: none"> • MPhil to PhD transfer • Placement assignment • SW Carpentry (tutor) <p><u>Transferable Skills</u> <i>Entrepreneurship, Intellectual property, Science in the economy</i></p>
Year 3	<ul style="list-style-type: none"> • Placement • International training school • CDT Summer School (tutor) <p><u>Transferable Skills</u> <i>Research planning, Proposal writing</i></p>
Year 4	<ul style="list-style-type: none"> • International conference • PhD Award <p><u>Transferable Skills</u> <i>Interview skills, Careers workshop</i></p>

DIS CDTs - Status

- ❖ The CDTs have been a very successful scheme so far
 - UCL will welcome its 5th cohort this year
 - The 1st cohort are now graduating
 - Will have enrolled > 50 students in the CDT

- ❖ Benefits
 - The formal S&C training significantly enhances the student's skillset
 - Excellent feedback from industry partners on aptitude of students
 - Mixing of students from different areas very beneficial
 - Enabled strong links with industry to be built
 - Bring in industry funding to create more studentships

- ❖ However....
 - STFC was not able to provide any studentships this year
 - Need better and increased long-term funding
 - Scheme only impacts upon a small fraction of STFC studentships
 - Need to ensure the benefits are available to all students

Industry Placements

- ❖ As part of CDTs, PhD students or PDRAs undertake 3/6-month placements
 - DIS related projects with CDT Partners
 - Greatly enhances training
 - Tools, techniques, work-flows and language used in industry
 - Promotes knowledge transfer
 - Build strong links with industry
 - Creates further opportunities
 - Impact skills/expertise developed in fundamental physics
- ❖ We've now been running placements for several years
 - Industry typically pays for the privilege
- ❖ Would be good to build similar scheme UK-wide
 - Allow PDRAs and academics in this programme to take part
 - Strong benefits to field: knowledge transfer, research outcomes, impact

