LHC Computing – the First 3 Decades

CHEP 1991: Tsukuba, Japan
vCHEP 2021: “everywhere”
[CHEP 2041: somewhere?]

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Overview

- LHC Computing started just after LEP collisions
  - Or even before?
- But certainly before the official approval of the machine or today's collaborations…

- Roughly speaking (by decade):
  1. **1990s: various R&D activities / projects;**
  2. **Exploration of grid / hardening / support;**
  3. **Data taking / production / analysis / RESULTS!**

Why This Talk?

- Motivation came from previous work on LEP data, documentation & software
- Strengthened by ESPP update symposium in Granada

★ **Tried to capture "official record" of LEP computing through planning documents of the 1980s, plus CHEP and other sources**

✧ **Many gaps / anomalies in these (Papers missing, some redacted, …) – better for the LHC???**

➢ **Important to plug the existing gaps now and capture / preserve better in the future (IMHO)**

Mass Storage (CHEP '91…)

- Initially foreseen to start LEP data taking using 6250 bpi round tapes **[Source: Computing at CERN in the LEP era]**
  - 3480 cartridge (200MB) offered only a small capacity increase but huge gains in reliability / automation
- **$O(10^6)$ "3480" volumes for LEP – $O(10^9)$ for LHC**
- Investigation (and production use) of various "high capacity" video cassettes (dual spool)
- **Plus IEEE Computer Society Reference Model for MSS**
- See HPSS, Lachmann but also CASTOR… [Unitree]
- Subject of 1993 CSC lectures (see slide notes)

➢ **Can we call this a success?**

The Rise and Fall of ODBMSs

- Prior to LEP, many were convinced that Fortran (or FORTRAN, depending on the version) would be the programming language "forever"
- **However, already from the early 1990s, there was considerable interest in OO – not just C++**
- Several projects (PASS, ROOT, RD41 (MOOSE), RD44 (GEANT-4), RD45 ("object persistency")) ran through the mid to late 1990s
- **By CHEP 2000, "all is not well" in ODBMS-land**

➢ **Partial success? (R&D must include some risk)**

Computing Technical Proposals

- Another important element of the story of LHC computing: the **ATLAS** and **CMS CTPs** (1996)
  - (TDRs, also for ALICE and LHCb, came >2000)
- **Written just over a decade before "first physics" was due, "ideas" were retained (see next) but not the "named solutions"**
- Specific references were made to the "**PASTA**" working groups but these reports can no longer be found (maybe some paper copies somewhere?)
- **An important part of the record and a reminder…**

Towards a Model of RCs

- The "Models of Networked Analysis at Regional Centres" (MONARC) project strongly influenced thinking on LHC computing
- (Later "married to the grid")
- **Networking bandwidth, reliability and costs were all big unknowns with a "fallback" of "continental" centres + "tapes in a suitcase"**
- (See also early LEP papers for their use of RCs)

➢ **Overall a (lucky?) success, thanks to .com bust(?)**

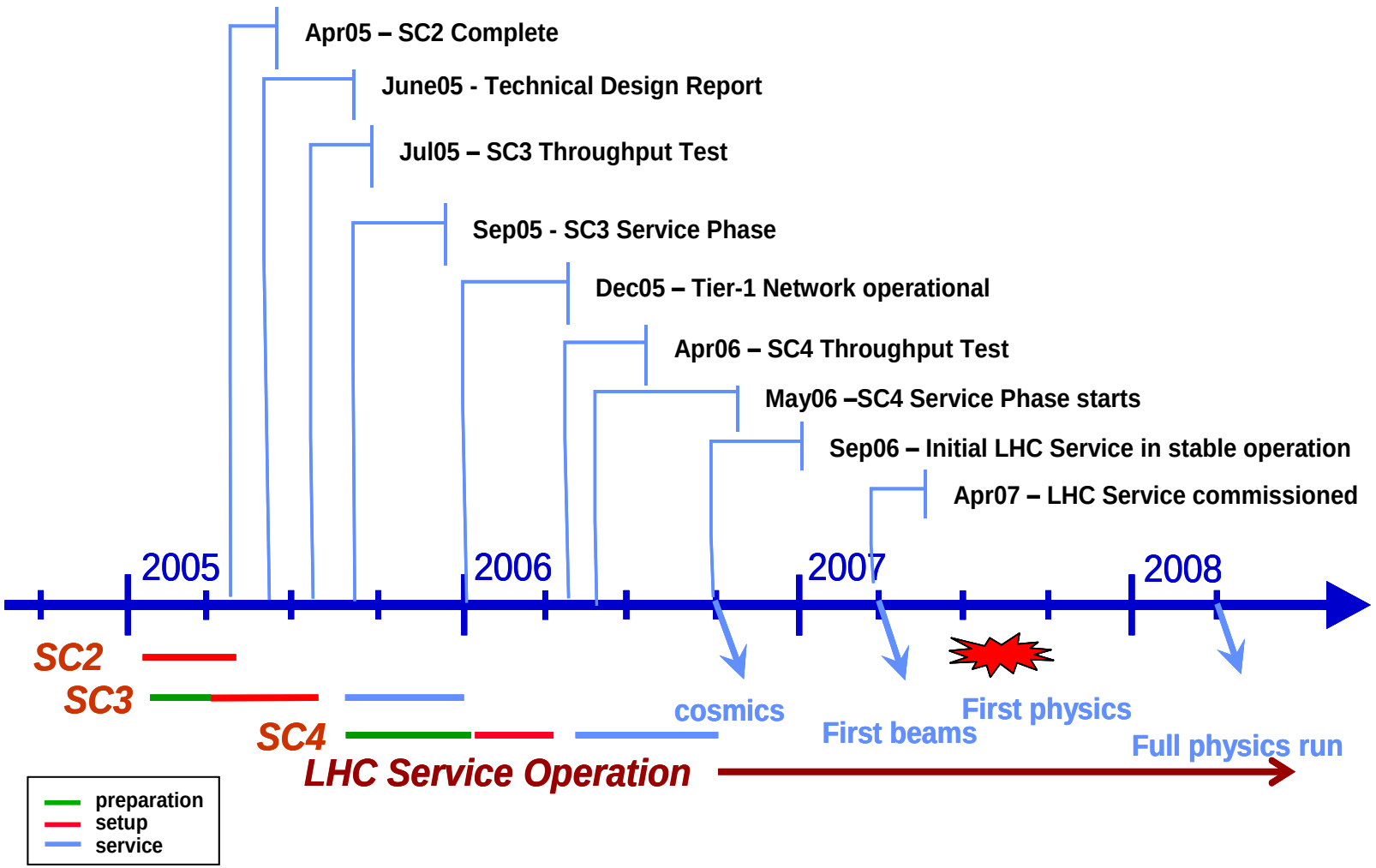
Enter the Grid

- Around the birth of the current millennium and marked by CHEP 2000 in Padua, the potential of grid computing enthused(?) many
- **This led to a whole series of projects around the world, including the infamous "WLCG"**
- Given how well the grid has performed, it is easy to overlook the effort (still) required

➢ **Service Challenges, CCRC'08, STEP'09, …**

▪ **Whilst these are described in project documents, CHEP presentations etc, these records are (again) not complete, nor future proof…**

LCG Deployment Schedule



“I think we have it”

- **Based on the “concluding remarks” by the DG, I think that we can consider LHC Computing – and WLCG – to be a success**

- **Not perfect, not static, requiring constant attention, upgrades and improvement**

- **(But I can’t even find the material from the seminar anymore)**

Whatever Next?

- **Future colliders – both lepton and hadron – are under consideration that would be natural successors of LEP / LHC**
- Starting possibly half a century after each, technology will have advanced to seem "like magic" to those (of us) working on the former machines
- **The challenges will nevertheless be huge but <u>different</u>**

- **We have seen successes, partial successes but no real failures**

- However, if there are possible lessons from the past we need to record – and preserve – this information and "knowledge" now (and then: i.e. fill the existing gaps)

➢ **Don't under estimate the challenges and discipline!**

Lessons (If Any…)

- **As is often repeated, predicting is difficult, especially if its about the future (N. Bohr)**
- Over a period of decades, technology is bound(?) to change enormously
- **In fact, we rely on it (way beyond "IT")**
- **Do we need to record our efforts, progress, dead-ends and even failures?**
- **(How) Is CHEP part of this? (The former, not the latter)**

➢ **We need to do better and ensure what has been captured is "complete" and "correct" at the time – it is much harder (sometimes impossible) later…**

What I Would Like to See

- A single collection in a TDR that covers all CHEP conferences (can overlap with others)
- **The agendas, talks and papers in "machine readable" format (i.e. OCR-ed / PDF)**
- **Clarification (and consistency) on how talks and papers are entered into the system**
- Preferably also the document / presentation templates and any other "obvious" meta-data
- From now on, also DOIs and ORCIDs

➢ **None of the above is currently true!**

CHEP 2041

- Will we be looking back at (HL-)LHC Computing?
- Will all of the above mentioned problems have been solved?
- Good luck, take care, thank you and Good Bye!

BACKSTOP MEANS BACKSTOP

UAB-LFAE 91-07

Computing at LEP

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(Invited talk at the Computing in High Energy Physics 91 conference, Tsukuba City, Japan, March 11-15, 1991)

A general review of computing at LEP is given, with emphasis on event reconstruction, data flow and storage, and physics analysis. The description is from the point of view of the strategies used to solve the problems; the reader is referred to the parallel session talks in CHEP91 for technical details and information which is specific to each of the four LEP detectors.

CERN-COMPUTING & NETWORKS DIVISION
CN/91/2
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HEPnet in Europe: Status and Trends

François FLUCKIGER

OCR-ing can improve quality!

1. Introduction

Although the use of large disk subsystems in Particle Physics data analysis has become common-place in the last 10 years, the random access features of disks have rarely been used. Most of the time, disks were used as magnetic tape emulators, with the advantage of simultaneous access by many users and elimination of the delay of mounting a tape. This approach was used, for example, by the MAC experiment at PEP [1], and then became more fomally implemented as the "tape staging" extensions to the IBM VM and VAX VMS operating systems. Some operating systems, from CDC for example, have supported tape staging for decades. In this paper, we describe the exploitation of true random access on large disks for event analysis of the ALEPH detector at LEP. The random access features were designed and implemented by V. Blobel in the input/output (I/O) modules of the BOS memory management package [2]. It should be noted that although the description always refers to disk files, all of the features are also available for magnetic tape cartridges staged to disk.

2. Why Random Access ?

High Energy Physics data are usually arranged in files, each corresponding to a period