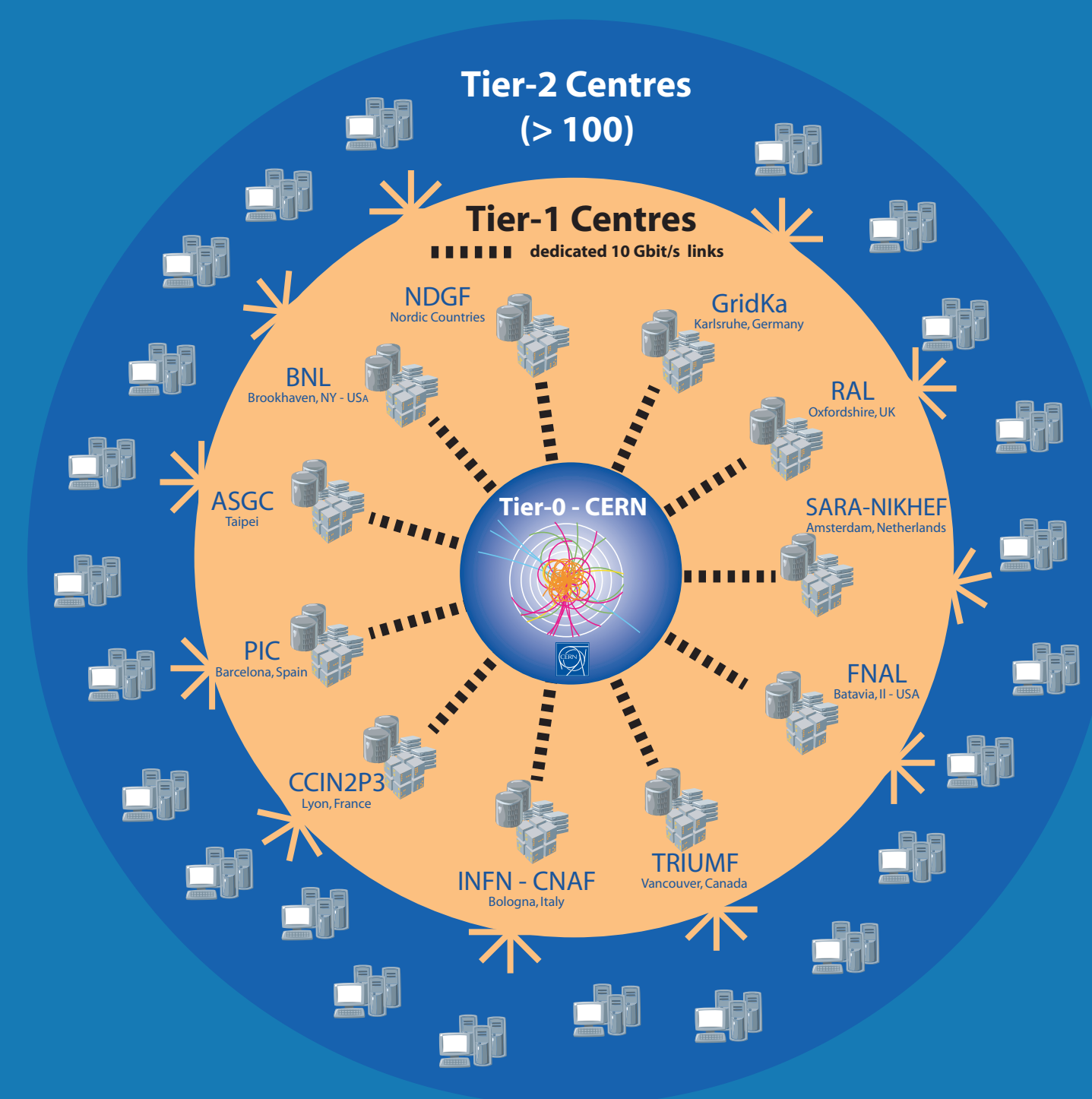




# The Worldwide LHC Computing Grid Project

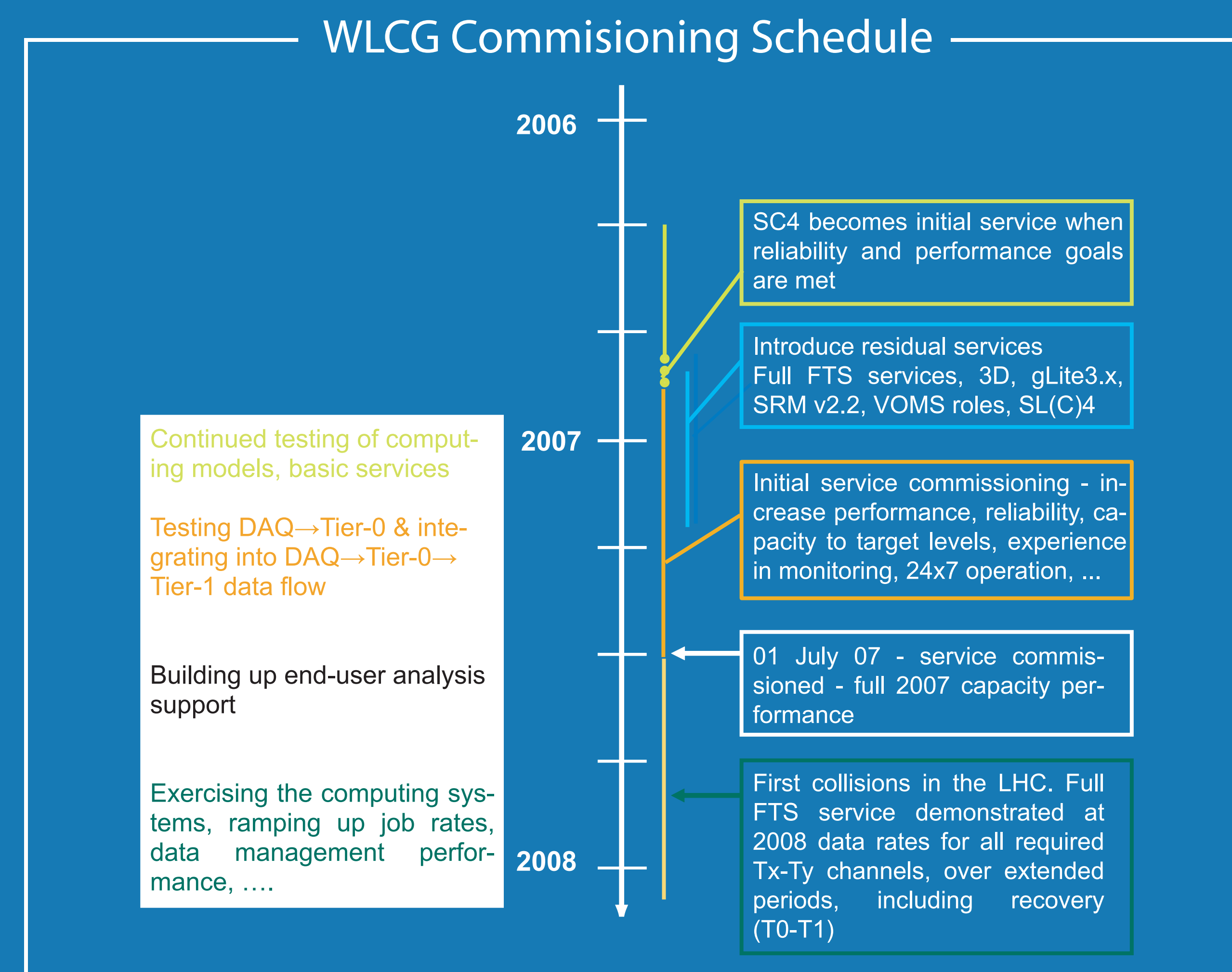
The world's largest scientific instrument, the Large Hadron Collider (LHC) is currently being assembled near Geneva, Switzerland. When operational, several petabytes of data will be generated every year by four large experiments for a period of at least ten years. These data will be acquired at rates up to nearly 2GB/s and will be analysed by thousands of physicists worldwide. In order to exploit the full discovery potential of the LHC, a worldwide Grid is currently being deployed. The Worldwide LHC Computing Grid project (LCG) is providing the distributed production environment for physics data processing for the LHC experiments. This is being performed in conjunction with other national or regional grid projects, including EGEE and OSG



LCG adopts a hierarchical model involving tiered sites with different functionalities. Tier0 is the host laboratory (CERN) where the data is acquired and where a full copy of the raw data is stored. Copies of the raw data and the output of the reconstruction are distributed across 11 Tier1 centres at a sustained rate between 50MB/s and 200MB/s. As well as storing these data, the Tier1 sites are responsible for the reprocessing of these data, serving the end-user analysis needs of physicists as well as providing additional services to the Tier2 sites. The Tier2 sites, some 15 - 30 per experiment, are largely devoted to the production and processing of simulated data, improved calibrations and also in most cases end-user analysis

## LCG Service Challenges

As part of the commissioning, a series of service challenges is currently being conducted, ramping up the service progressively. These challenges address not only the need to distribute data reliably between many sites around the world – not in burst mode but 24x7 for essentially all of the production lifetime of the machine, but also and much more importantly meet the needs of the experiments for all of their offline data processing.



# Building the LCG Service

The first three of four service challenges have already taken place and focused on attaining reliable file transfer services between some of the main sites involved in the LCG for extended periods of time in a production-like environment. The last two challenges built on this infrastructure work to provide services satisfying the full requirements of the LHC experiments for processing and analyzing their data at progressively higher data rates involving more and more sites. The setup that was used for the final service challenge became the initial production service in Q3 2006 – an extremely aggressive timescale given the overall complexity of the problem.

Service Challenge 4 demonstrates that all of the offline data processing requirements expressed in the experiments' Computing Models, from raw data taking through to analysis, can be handled by the Grid at the full nominal data rate of the LHC. All Tier1 sites are involved, together with the majority of the Tier2s. The challenge needs to successfully complete at least 6 months prior to data taking.

The target total aggregate data rate out of CERN is just over twice that demonstrated in Service Challenge 3, at 2 GB/s. We were not fully able to demonstrate full nominal Tier0-Tier1 transfer rates over extended periods, let alone recovery rates (targeted at twice nominal). However, experiment-driven data transfers (ATLAS and also CMS) achieved rates close to the target of full nominal rates for a single experiment (about half of the total rate for all experiments) under much more realistic conditions than for previous transfers.

Centre	T0 → T1 Predictable Data Taking	T1 → T2 Bursty User Needs	T2 → T1 Predictable Simulation	T1 ↔ T1 Scheduled Reprocessing
IN2P3, Lyon	168.9	286.2	85.5	498.0
GridKA, Germany	179.3	384.9	84.1	395.6
CNAF, Italy	214.7	321.3	58.4	583.8
FNAL, USA	110	415.0	52.6	417.0
BNL, USA	186.5	137.7	24.8	358.0
RAL, UK	111.1	108.3	36.0	479.4
SARA/NIKHEF, NL	107.0	34.1	6.1	310.4
ASGC, Taipei	72.7	126.5	19.3	241.2
PIC, Spain	55.3	167.1	23.3	294.5
Nordic data Grid Facility	41.8			62.4
TRIUMF, Canada	19.2			59.0

Global Inter-Site Rates (MB/s)

