Post-Mortem of the NERSC Franklin XT Upgrade to CLE 2.1

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Introduction

This presentation will discuss the lessons learned of the events leading up to the production deployment of CLE 2.1 and the post install issues experienced in upgrading NERSC's XT4™ system called Franklin

NERSC

- NERSC is a Production Computing Facility for DOE Office of Science
- NERSC serves a large scientific population
  - Approximately 3,000 users,
  - 400 projects,
  - 500 code instances
- Focus is high end computing services

NERSC-5 Systems

Franklin (NERSC-5): Cray XT4 installed in 2007

- 9,680 compute nodes; 19,360 cores
- ~ (100 Tflops/s peak)
- 16 Login, 28 I/O Server Nodes (4 MDS Nodes)
- 2 Boot, 2 syslog, 4 network

Silence upgraded to Quad-Core in summer 2008

- 68 compute nodes; 272 cores
- 2 login, 4 I/O, 4 DVS
- 1 Boot, 1 syslog, 2 network

Gulfstream (partition of Franklin) to "burn-in" upgraded Quad-Core H/W

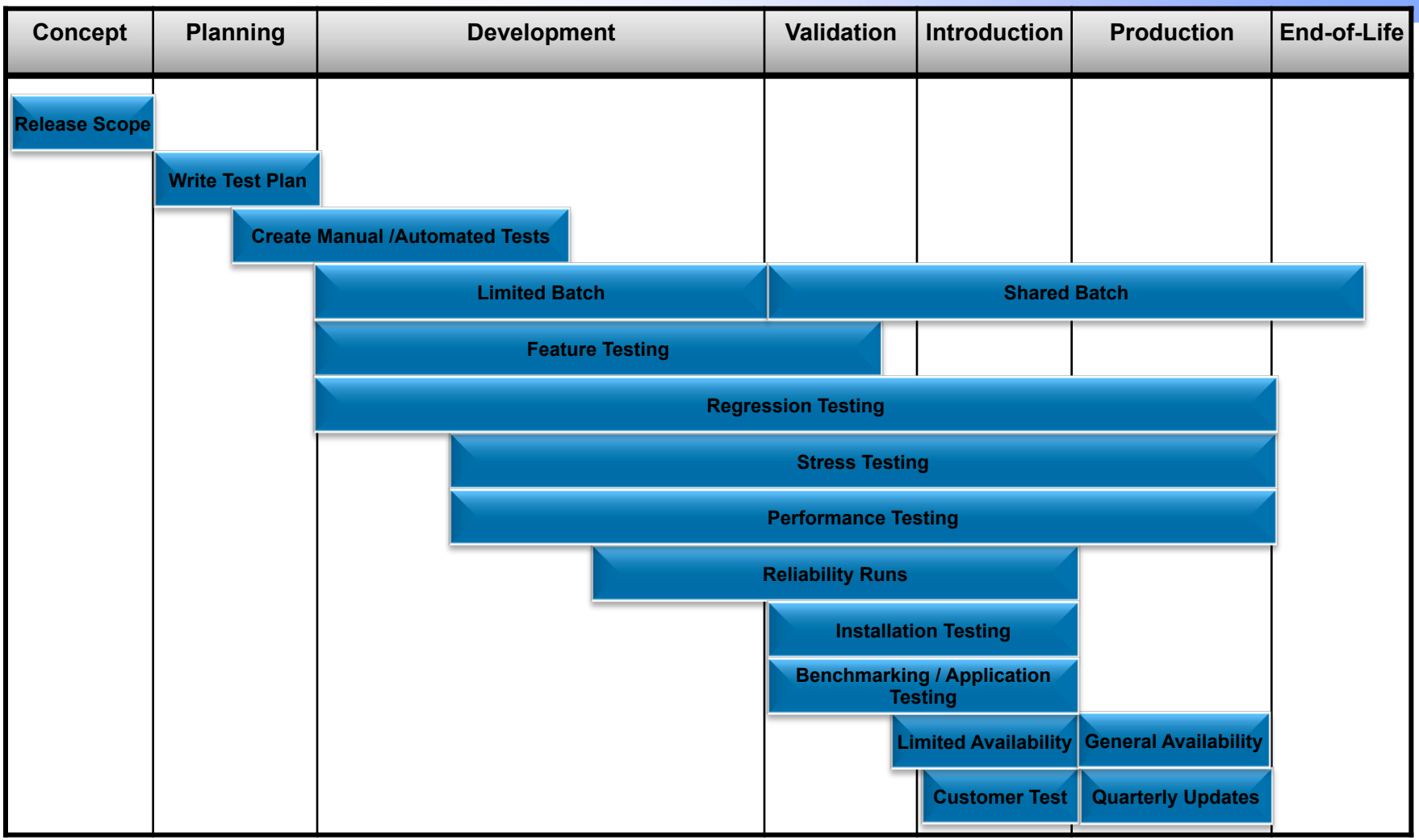
- maximum size of 48 cabinets, at largest stage, max 18,432 cores
- 2 login, 4 I/O, 4 DVS
- 1 Boot, 1 syslog, 2 network

Franklin Quad-Core upgrade completed in October 2008

- 9,592 nodes; 38,368 cores
- ~ (355 Tflops/s peak)
- 16 Login, 56 I/O Server Nodes (4 MDS Nodes)
- 20 DVS, 2 Boot, 2 syslog, 4 network

Cray's Test Strategy

Cray Product Life Cycle and Test Participation



Cray System Test Components (Suites)

- **OS:** system calls, commands, OS features
- **Interconnect:** portals, Seastar, inter-node communication
- **MPI:** MPI based applications/test codes
- **SHMEM:** shmem based applications/test codes
- **UPC:** UPC based applications/test codes
- **CUST:** 22 current customer application codes (6-18 months)
- **Application:** over 500 older applications which have found problems
- **PERF:** specific performance measures for system
- **IO:** exercise IO/networking capabilities and the file system
- **ALPS**

Cray Use of Test Suites

- **Regression tests:**
  - **All automated suites run weekly; manual tests also run**
  - **Results are checked for Pass/Fail**
- **Stress tests:**
  - **All suites run concurrently to put a heavy load on the system for four to six hours**
  - **Focus is on how the system holds up instead of individual Pass/Fail**
- **Reliability runs:**
  - **Weekly, run system for 72 hours straight under heavy load**
  - **Goal of no overall system failures, no nodes lost**

Note: all testing performed with released versions of 3rd party software (e.g. MOAB/TORQUE, PBS Pro) supported by Cray and documented in the Release Overview.

Other Cray Important Testing

- **Installation Testing – upgrade and initial install testing**
  - **Software group testing**
  - **Service group testing**
  - **Use draft installation documentation and provide feedback**
- **Benchmarks/Applications**
  - **Run customer applications for correctness and performance**
  - **Use Cray Programming Environment and provide feedback**
- **Performance Testing**
  - **Specific automated performance tests are run to measure: node-to-node throughput, ping-pong, multi-pong, all-to-all, HPCC latency, 8 node barrier times**
  - **Suites: HPCC 1.2.0, IMB, Pallas, Comtest (Sandia), memory usage-service and compute nodes, Lustre read/write**

Cray Customer Test Program Goals

Partner with 1-2 customers to obtain additional exposure and testing for upcoming feature releases

Benefits:

- Customers will be able to find problems that Cray would not experience otherwise: scaling, production workload, specific customer testing of some features
- Prove the release is stable at scale by testing in three stages:
  - Dedicated time Cray testing (features at scale, overall system at large scale)
  - Dedicated time "friendly user" application testing
  - Run solidly in production at customer site
- Gives Cray the opportunity to fix these problems before most customers upgrade to GA
- Several weeks in duration; problem reporting via Crayport/ Bugzilla

Gulfstream Test Schedule

Central Time	Pacific Time	Friday 9/26/08	Saturday 9/27/08	Sunday 9/28/08	Monday 9/29/08	Tuesday 9/30/08	Wednesday 10/1/08	Thursday 10/2/08	Friday 10/3/08	Saturday 10/4/08	Sunday 10/5/08	Monday 10/6/08	Tuesday 10/7/08	Wednesday 10/8/08
2am-6am	12am-4am					Apps Apps Apps Apps	Friendly Users & Workload	Perf Perf Perf Memtest	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload
6am-10am	4am-8am		HW Update	HW Update	HW Update	Apps Apps I/O Functional DVS & NFS	Friendly Users & Workload	Memtest Memtest HW Update HW Update	Friendly Users & Workload	Friendly Users & Workload Hw/Sw Update	Friendly Users & Workload	Friendly Users & Workload HW Update	Friendly Users & Workload	Friendly Users & Workload HW Update
10am-2pm	8am-12pm	Install 2.1.36 Install PE Setup DVS, CSA, & CPR	24hr RunLong	Last chance for 24hr RunLong HW stability test	HW Status NERSC Security Scan	HW/SW Status NERSC Workload Checkout	HW/SW Status Friendly Users & Workload	HW/SW Status Friendly Users & Workload	Friendly Users & Workload & Cray Apps	DVS & NFS DVS DVS DVS	Friendly Users & Workload	Stress HSN Stress Stress Stress	CPR Functional CPR CPR CPR Demo	24hr RunLong
2pm-6pm	12pm-4pm	Install PE Quick checkout Security Scan		HW Status	Queue issue MemTest MemTest Platinum	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload & Cray Apps	Stress Scale Stress Stress Stress	Friendly Users & Workload	DVS & GPFS DVS DVS DVS	CPR CPR & NSFv4 CPR CPR	
6pm-10pm	4pm-8pm	24hr runlong			Platinum Platinum Apps Scale Apps	CPR Functional CPR CPR CPR	DVS & GPFS DVS DVS DVS	Cray Apps & Friendly Users	Cray Apps & Friendly Users	Stress Stress Stress Stress	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	
10pm-2am	8pm-12am				Apps Apps Apps Apps	CPR CPR CPR CPR	Perf Scale Perf Perf Perf	Cray Apps & Friendly Users	Cray Apps & Friendly Users	Apps Run Apps Apps Apps	Friendly Users & Workload	Friendly Users & Workload	Friendly Users & Workload	

Legend
Cray Hardware
Cray Software
NERSC
Shared
NERSC offsite

NERSC Test Strategy

Silence Test Strategy

- Before any software is installed on Franklin, it is installed and checked out on a single cabinet - independent test system - called Silence
- CLE 2.1 was first installed on Silence back in June 2008
- The primary testing goals for Silence was to:
  - Identify procedural issues
  - Become familiar with the upgrade process
  - Validate the new functionality achieved by the upgrade
  - Gain insight into the stability of the upgrade
  - Perform basic functionality tests
  - Perform limited performance tests

Gulfstream Test Strategy/Results

- Gulfstream, was a temporary partition of Franklin and was being used as a rolling quad-core hardware upgrade vehicle
- CLE 2.1 was first installed on Gulfstream back in July 2008
- The primary testing goals for Gulfstream was to:
  - Build on Silence testing goals particularly issues of scale
  - Gain insight into the stability of the upgrade at scale
  - Perform scale performance tests
- Test results positive; no major issues that didn't have a workaround

Franklin Post 2.1 Install

- Joint NERSC/Cray decision to proceed with Franklin 2.1 upgrade made; upgrade was preformed December 3, 2009
- Issues encountered:
  - Bad SeaStar netmask caused networking issue
  - Access control problem with pam_access.so
  - Franklin stability worsens
  - Virtual Channel 2 impact unknown and NERSC turns off
  - HSN congestion appears related to many system crashes
  - MPT 2.0 applications and libraries crashing system
- Many new patches get installed (December – March)

Light At The End of Tunnel

- In mid March, numerous patches installed to resolve SeaStar related issues and the NERSC wrapper for aprun (that blocked MPT2 compiled applications) appeared to be working
- Franklin still had a large number of individual patches installed and getting new fixes was becoming increasingly more difficult
- So the mother of all Patches Sets (UP01) is under consideration to install – NERSC takes the plunge and installs Patch Sets: PS01, PS01a, & PS02

Summary

- After nearly five months, the end result has been a significant improvement in the software stability of the system
- Even with all of the shared pain, amongst Cray and NERSC staff, and even NERSC users, regarding the 2.1 upgrade of Franklin; the eventual benefits (2.1 stability and functionality) out weighed the pain
- Many lessons were learned along the way also…

Lessons Learned Highlights

- Even when testing is going well; don't schedule a major upgrade right before a major holiday
- Because of the large number of changes incorporated in CLE 2.1, including upgrades to SuSE SLES and Sun Lustre, the release would have been better named "CLE 3.0"
- Open, two-way communications are key to the project success
- The assumption that a successful test on Gulfstream meant that CLE 2.1 was ready for NERSC production.
- Need to really run on a large "production" system (not just a set of test systems) at a customer site before officially GA'ing
- Utility was needed to identify non-compatible software (MPT)
- Customer needs ability to review all outstanding bugs before deciding to go production (GA) – first large site

Recommendations

- Add additional tests to the Cray test suite include:
  - Injection of additional HSN traffic to simulate congestion
  - 3D Torus test
  - I/O stress test, e.g. IOR test
- Increase the size of Cray's test system to better validate scaling issues., beyond the current 16 cabinet test system
- Continue joint Cray and customer Post-Mortems with future test partners
- NERSC and Cray should formally and jointly write a "Post-Mortem" document
- Cray and NERSC should have reviewed all (internal) problems previously found in testing
- Finally, Cray should allow NERSC to share all of its CLE 2.1 bugs with other interest sites

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