LSST Key Numbers

A need has arisen for the a single, agreed-upon, list of values with key numbers that we will use consistently across all presentation for Final Design Review and beyond (esp. as they relate to data volumes, etc.).

Below is that list. Please cross-check your slides and make sure they're consistent with these numbers.

This list must be updated on CCB or DM/TCT actions that cause the underlying numbers to change. Robert McKercher is responsible for keeping track.

Note that a version of this list is also in Docushare as Document-16168. There is an open JIRA issue, ~~PST-21~~ - Updates to Key Numbers DONE , for the updating of the list.

Principal references:

- LSST Science Requirements Document (SRD), LPM-17
- LSST System Requirements (LSR), LSE-29
- Observatory System Specifications (OSS), LSE-30

Parameter	Value	Notes	Formal Source Document (s)
Fiducial number of visits per pointing in the main survey.	825	Given by the SRD	LSR-REQ-0098, **Nv1Sum**
Fiducial main survey area	18,000 deg^2	Given by the SRD	LSR-REQ-0098, **ASky**
Estimated total covered area, including special programs	25,000 deg^2	• Includes the estimate for the extra area covered in the northern Equatorial spur (for asteroids), and the southern galactic cap (Magellanic clouds). Survey-strategy dependent. • The true covered area will strongly depend on the details of the strategy, and the decision on how to spend the 10% time devoted to special programs. The number given is a "not-to-exceed" number (from the data sizing point of view).	LSE-81 cell G92
Single exposure 5-sigma point source depth	u = 23.9 g = 25.0 r = 24.7 i = 24.0 z = 23.3 y = 22.1	Design spec from the SRD.	SRD
10-year idealized 5-sigma point source depth	u = 26.1 g = 27.4 r = 27.5 i = 26.8 z = 26.1 y = 24.9	*Cadence dependent;* this is an illustration from the SRD from a plausible OpSim run assuming the above single-exposure depths.	SRD
Number of visits collected over 10 years	2.75 million	• This is now in the OSS, as a requirement on number of exposures (550 thousand per year). It it a not-to-exceed number. • OpSim has achieved ~2.6M	Computed from OSS-REQ-0190
Number of images collected in 10 years	5.5 million	Simply equal to 2.75 * 2	OSS-REQ-0190
Number of visits per night	"about a 1000"	This is 2.75 million / 10 year / 300 days/year = 920 visits/night, rounded up to 1000.	Derived from OSS, SRD
Number of calibration exposures	450/day	• This is an average • Requirement in the OSS, comes from the Calibration Plan.	OSS-REQ-0194

Number of data collected per 24 hr period	"about 20 TB"	This is the number of exposures per night + calibration exposures per day(= !2450), with 8.2 GB per exposure (562*2098 pixels including overscan × 16 amplifiers × (189 science CCDs + 4 wavefront sensors) × 18 bits/pixel / 8 bits/byte). Considering that the in-memory form and the compressed form are both varying physical representations of the "true" logical information, we use 18 bits/pixel.	Derived from OSS, SRD; LSE-81 for pixel size upper bound
Number of data for 10 year mission	"about 60PB"	10 years x 298.35 observing nights/year = 1.5M total calibration images = 1.35M total calibration images = 7M total images = 8.2GB x 7M total images = 57.4 PB of raw data = 56.2 PB Per-24 hour period ~ 2450 science and calibration images/24 hr period = ~ 20 TB/24 hr period (~20 * 300 * 10 = ~60 PB which matches total)	
Standard visit exposure duration	15 s	A visit consists of two exposures. Specified in the SRD.	SRD
Time to take a single exposure	18 s	• One second to open one shutter blade set. • Fourteen seconds of fully open exposure. • One second to close the other shutter blade set, and • Two seconds to read out the FPA.	OSS
Expected median slew time between visits	4.8 s	Derived from the current baseline cadence (see Observing strategy white paper, section on baseline cadence minion_1016). The mean value for minion_1016 is 6.8 s. Similar, but not identical, values are expected for future cadence realizations. Requirement: 5 sec (OSS-REQ-0289)	Derived from minion_1016 analysis
Time to take one visit in normal survey mode	Median: 39 s Mean: 44 s	Computed from two 18-second units, with the 5-second slew overlapped with the 2-second readout of the second exposure, thus 18 + 18 - 2 + 5 = 39 seconds (and the mean should be 44 seconds, as the mean slew time is 10 seconds). (Slew times taken from OSS-REQ-0289, not from simulation.)	Derived from OSS
Estimated number of objects in DR11	37 billion	• 20 B galaxies, 17 B stars. Note that uncertainties on the number of stars is significant (on order of ~30%), and accounted for in the sizing model. Computed from LSE-81 by dividing B66 by (1+C52), the margin for galaxies, and D66 by (1+C51), the margin for stars. • Some of these will be objects ***outside*** of the main survey area (in the deep drilling fields, northern Equatorial spur, Magellanic clouds, etc.) • Codified as a requirement in the OSS.	LSE-81 OSS-REQ-0192, OSS-REQ-0193
Estimated number of single-epoch sources in DR11	7 trillion	Comes from the DM sizing model (LDM-141, db2 sheet), by dividing F17 (number of sources in DR11) by 1.28 (the technical margin factor, derived by dividing D17 by 37 billion above). (this is a reasonable answer to the question "how many rows are there in your database")	LSE-81 LDM-141
Estimated number of forced measurements in DR11	30 trillion	• This is "forced photometry", i.e., a flux measurement performed at the position of all objects in all epochs. • Computed as 37 billion objects * 825 observations; it's a very rough estimate. DM sizing model, with technical margins included, assumes 50 trillion.	LSE-81 LDM-141
Estimated numbers for DR1 release	Objects: 18 billion Sources: 350 billion ForcedSources: 0.75 trillion	• Number of objects comes from the DM sizing model (db2!E6), divided by the 1.28 margin (see above). • Similarly so for the number of sources • Number of forced sources is computed as 18 B * (825/10years/2). The final division by 2 is to account for DR1 being done using just 6 months worth of data.	LSE-81 LDM-141
Average number of alerts per night	"about 10 million"	The science estimate used to be 2M per night. However, this did not include the Galactic plane where we'll have significantly more variability. Also, the SRD requires us to support ~10k/visit, which roughly translates to ~10M /night; before it was interpreted as the "peak", but we didn't have a strong justification why. We're now treating it as an average, so the number of alerts per night flows from that.	SRD

Network bandwidths	• 100 - 600 Gbps Cerro Pachon - La Serena • 40 - 200 Gbps La Serena - Santiago • 100 - 300 Gbps Santiago - Florida • 100 - 200 Florida - Chicago, Chicago - Champaign	The 2 x NNN nomenclature is designed to convey that the data will be transmitted through two independent links; if one gets cut, the other one continues to operate. DM and Camera baselines can operate with a only a single link being up. x00 - y00 range indicates lower end (some links down) - upper end (all links operating). Any link would go to zero if all links are down, but that is deemed < 0.1% probability. NOTE: As of 20171220 La Serena - Santiago still negotiating for 100 Gbps lower end, 75% likely	LSE-78, LDM-148
Data and compute sizes	• Final image collection (DR11): 0.5 Exabytes • Final database size (DR11): 15 PB • Final disk storage: 0.4 Exabytes • Peak number of nodes: 1750 nodes • Peak compute power in LSST data centers: 1.8 PFLOPS	• The sizes include the technical margins that DM included in their sizing models. That is, if you took the expected number of objects, sources, etc., and plugged them in the model, you'd obtain lower numbers than the table above. • The numbers for nodes and storage include the Archive and Base centers. • The database size includes data and persistent overhead (does not include temporary disk space to run analyses). • The image collection includes 24 PB of raw images, 16.5 of processed, retained, data (coadds, master calib, cutouts, epo, disk-based science calibrated, disk-based templates), and 475 PB of virtual data (all science calibrated exposures and templates not already on disk). These are all *compressed* sizes; uncompressed size is roughly 2x larger. • *These numbers are computed/transcribed from LDM-141 in Document-11928 (a powerpoint presentation). See that slide set for detailed explanation on how they were derived.*	LDM-141 LDM-144
Number of Data Releases	11	DR1 will include the first 6 months of data DR2 will include the first year of data DR3 will include the first two years of data ...	SRD
Date of DR1 release	time of ops start + 12 months	A common misconception is that the first data release will be ***released*** 6 months after the start of the survey. ***It will be released 12 months after the start of the survey***. It's because we collect data for 6 months, and then it takes 6 months to process it.	Ops plan?
Read noise	<9e- rms, at nominal 2 second readout time	This top level noise budget includes all sources internal to the camera system that contribute to the base noise in each pixel, including readout noise, residual noise from dark current, additional noise in the electronics, etc... The camera read noise requirement per exposure is derived from the OSS requirement of 12.7e- per visit and the standard definition of two exposures per visit.	LSE-59 Camera Subsystem Requirements CAM-Req-0020
CCD Blooming Full Well	Pixel charge capacity shall be no greater than 175,000 electrons.	Defined as the point at which the detector response (volts out divided by mean per pixel integrated photo-generated charge) saturates when illuminated by a flat field.	CCD-008 in LCA-128
Etendue (A Ω)	319 m^2 deg^2	This value comes from doing the numerical integration of (effective aperture * dFOV) over a 1.75 degree radius in 0.02 degree increments, taking into account the vignetting profile from the optical design. Note that this is purely a property of the optical system. It doesn't include focal plane fill factor.	Document-7512
Field of View	3.5 deg (9.6 deg^2)	From LSST baseline optical design	LSE-11 sec 1.3.1
Primary Mirror Diameter	8.4 m	From LSST baseline optical design	LSE-11 Table 7
On-axis effective clear aperture	6.54 m	M1 clear aperture diameter * sqrt(on-axis vignetting ratio) M1 clear aperture diameter = 8.36 m on-axis vignetting ratio = 0.61	Document-7512

Area-weighted effective aperture over FOV	6.49 m	Diameter of the circle whose area is equal to (319 m^2 deg^2)/(9.6 deg^2)	Document-7512
Final f-ratio	f/1.233	From LSST baseline optical design. This varies with band slightly. u= 1.232, g/r/I = 1.233, and z/y = 1.234.	LSE-11 Table 5