

Scientific Visualization of Extremely Large Distributed Astronomical Surveys



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Introduction

- Euclid Space Mission (ESA-M)
 - Extra galactic surveys (visible, infrared, spectroscopy)
- 10's of PB data
- Collaborators all over the world
- Multiple Science Data Centers
- Multiple Use Cases - status of processing, data release etc.

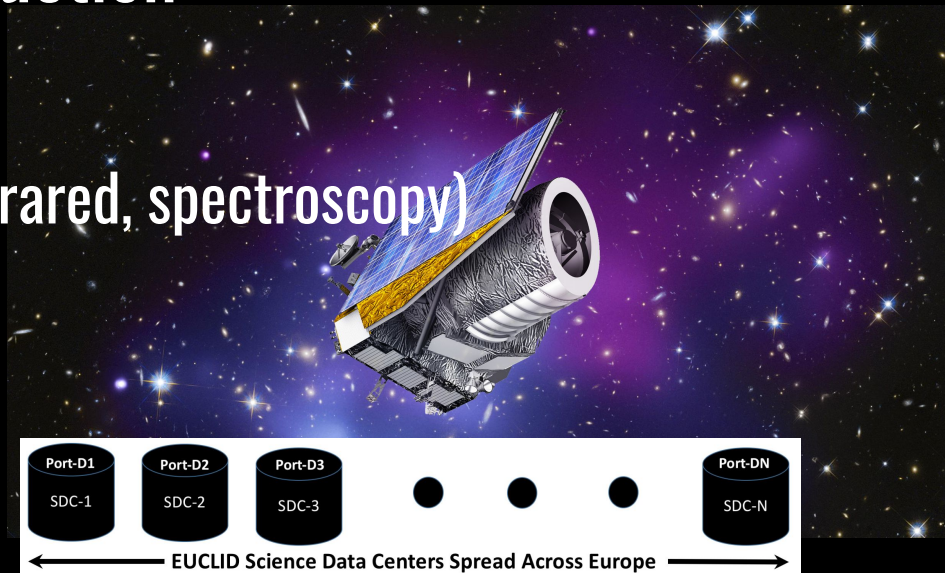


image source: ESA website



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Challenges

- Need a Distributed Visualization framework
- SDCs (heterogeneity)
- Network between SDCs - from 10s to several 100s Mbps
- Data availability/Progress according to Observation Plan
- Scalable, Flexible, Future proof framework

Two prong approach → reduce the data size (optional) and
→ enable distributed visualization



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Visualization Framework

Demand



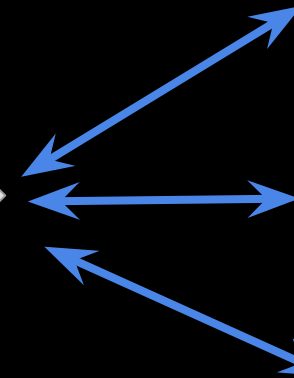
Visualization
Software
(Aladin)

Supply

SDC 1

SDC 2

SDC n



- Real time, Interactive
- Desktop feel but no copy



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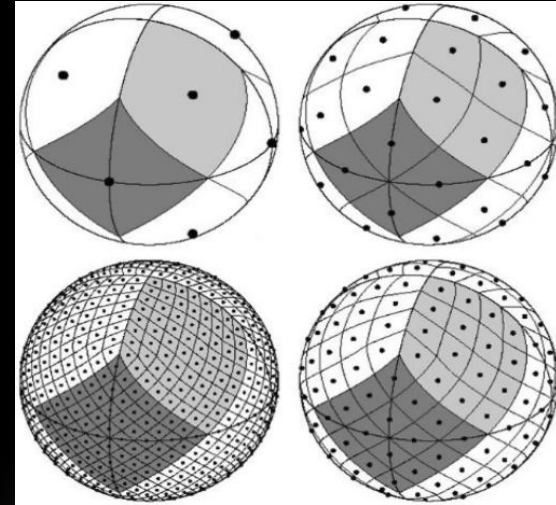
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HiPS Survey

HiPS is a hierarchical tiling mechanism developed by CDS (P.Fernique et al, A&A 578, 114, 2015)

It enables multilayer visualization

- HiPS is the defacto standard for survey maps
- HiPS is http compliant

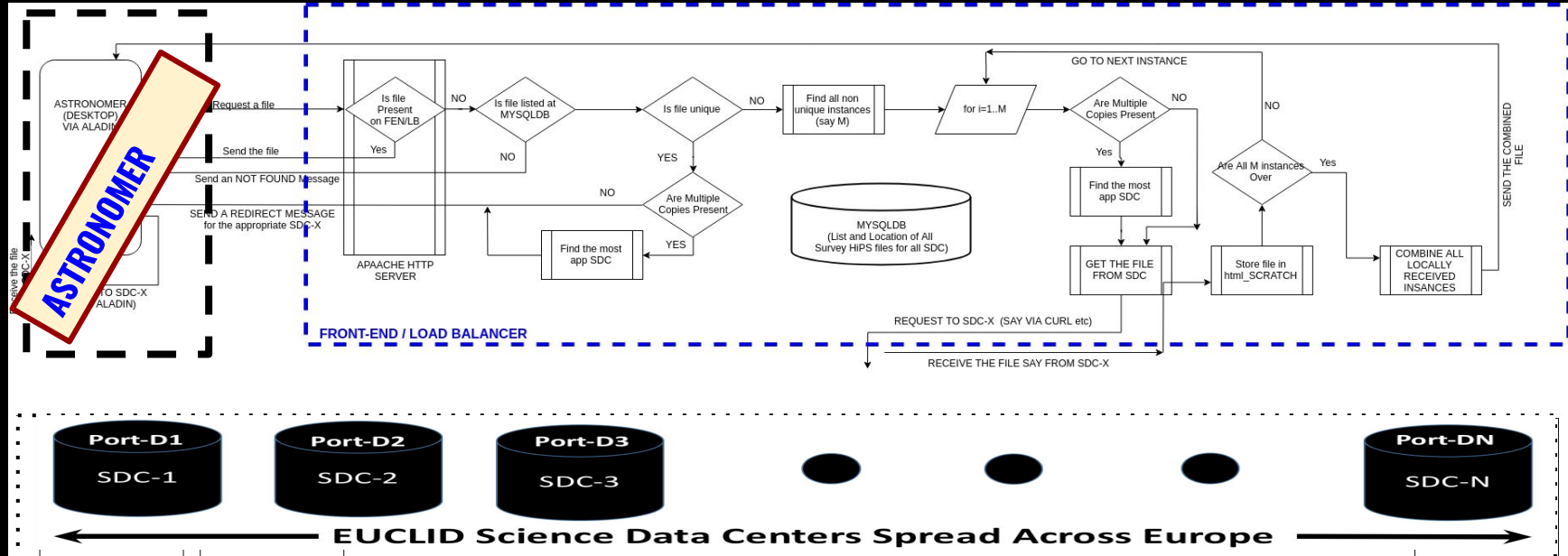


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Visualization Framework with LAMP Stack

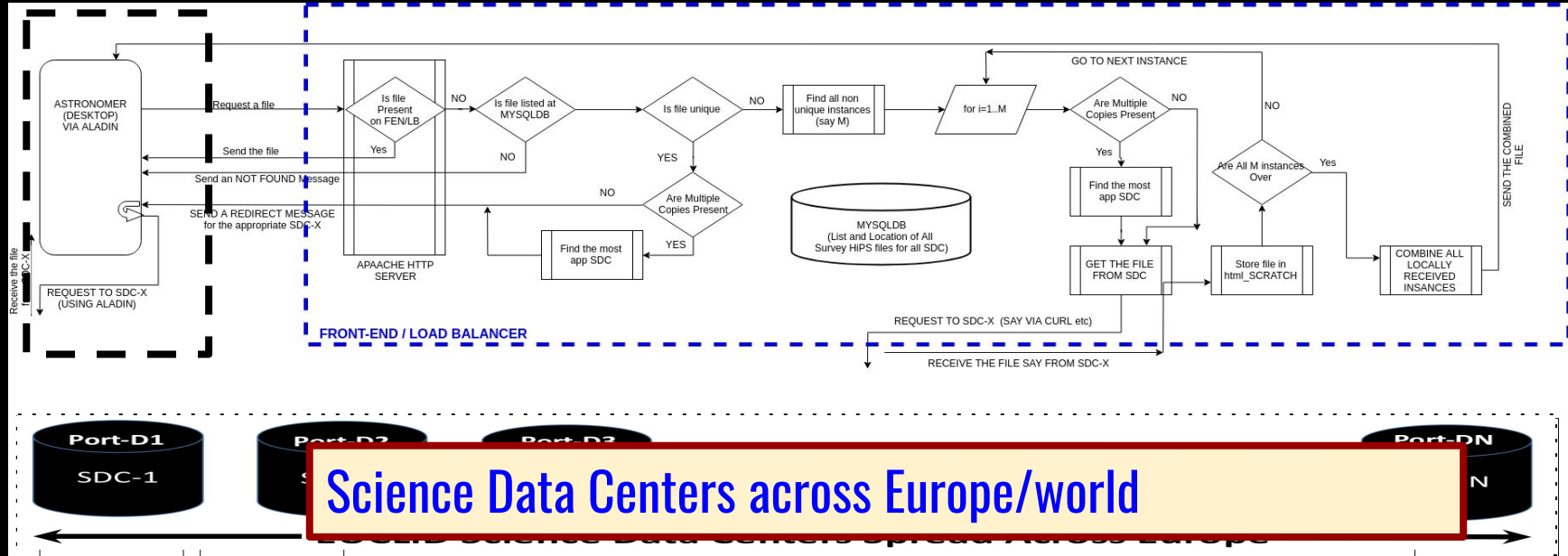


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Visualization Framework with LAMP Stack

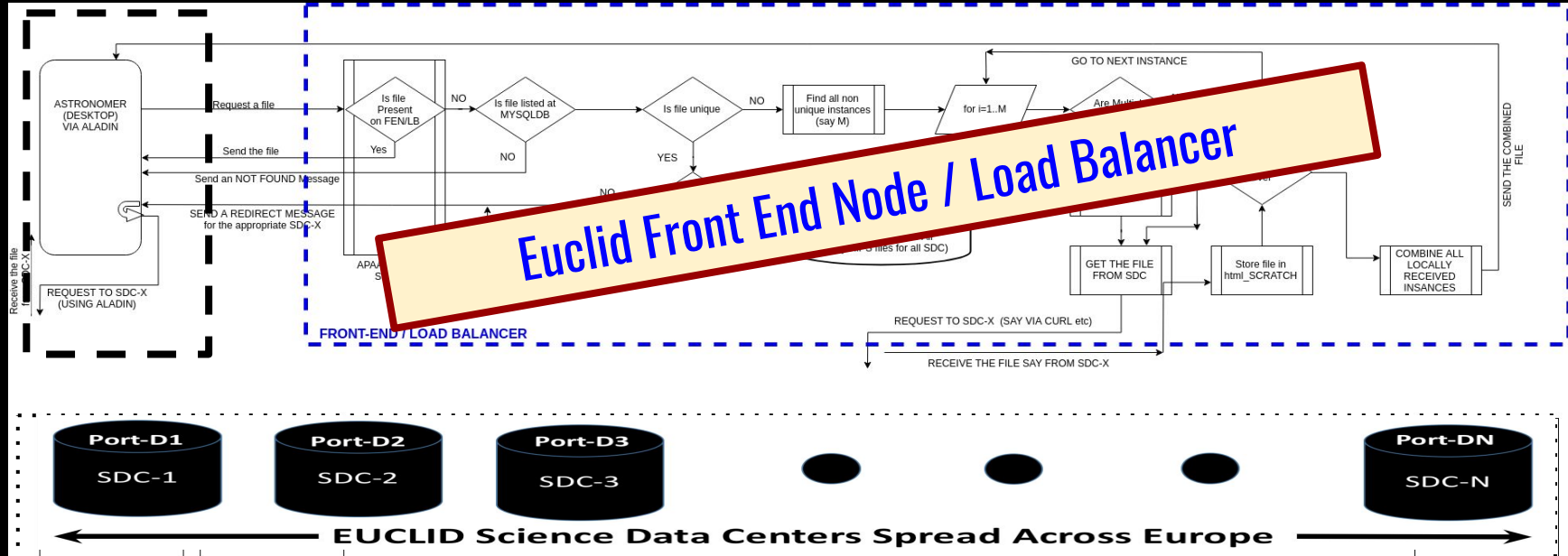


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Visualization Framework with LAMP Stack

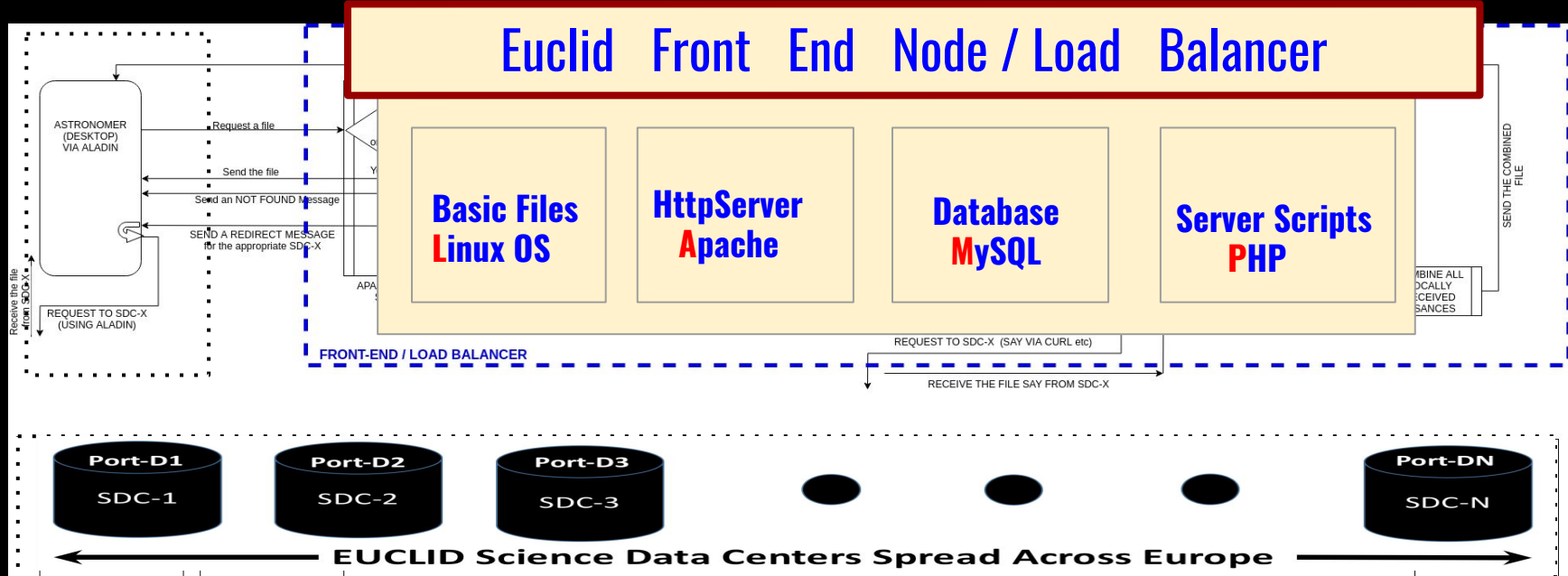


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Visualization Framework with LAMP Stack



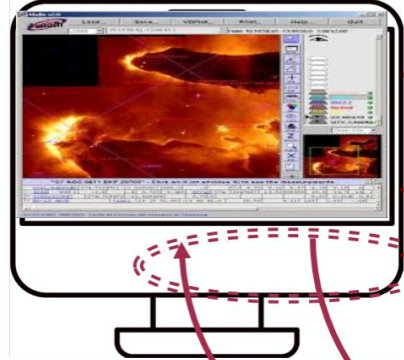
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Fully Distributed Visualization

ASTRONOMER's Desktop



Request (HTTP) file/info

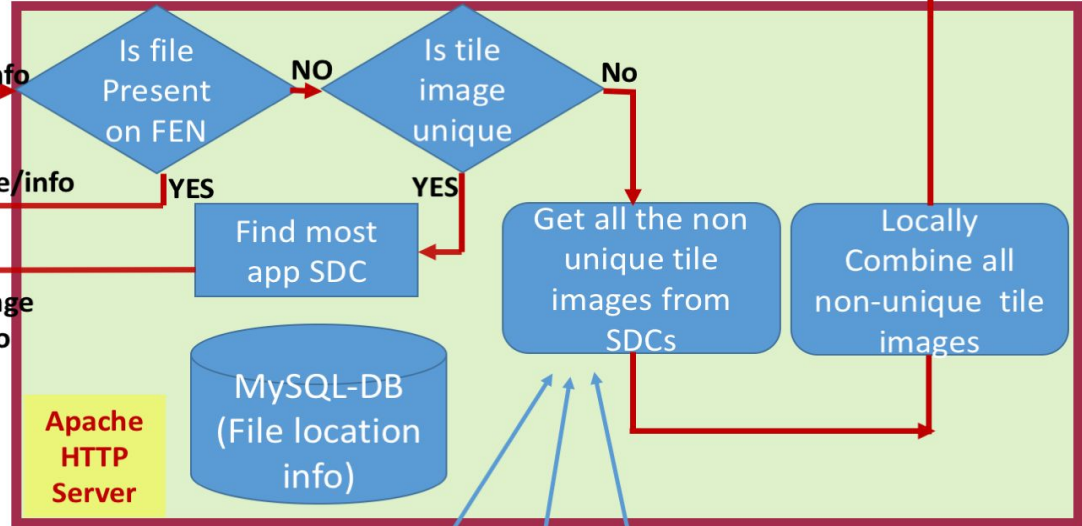
Send requested file/info

Send Redirect Message
with appropriate info

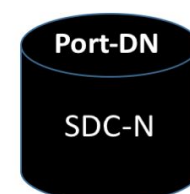
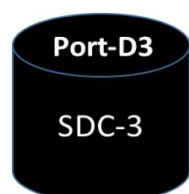
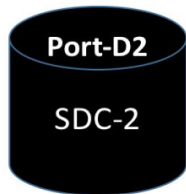
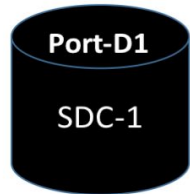
Receive file
from app SDC

Request (HTTP) file
from app SDC

Send Combined tile image



Euclid - FRONT-END cum LOAD Balancer Node

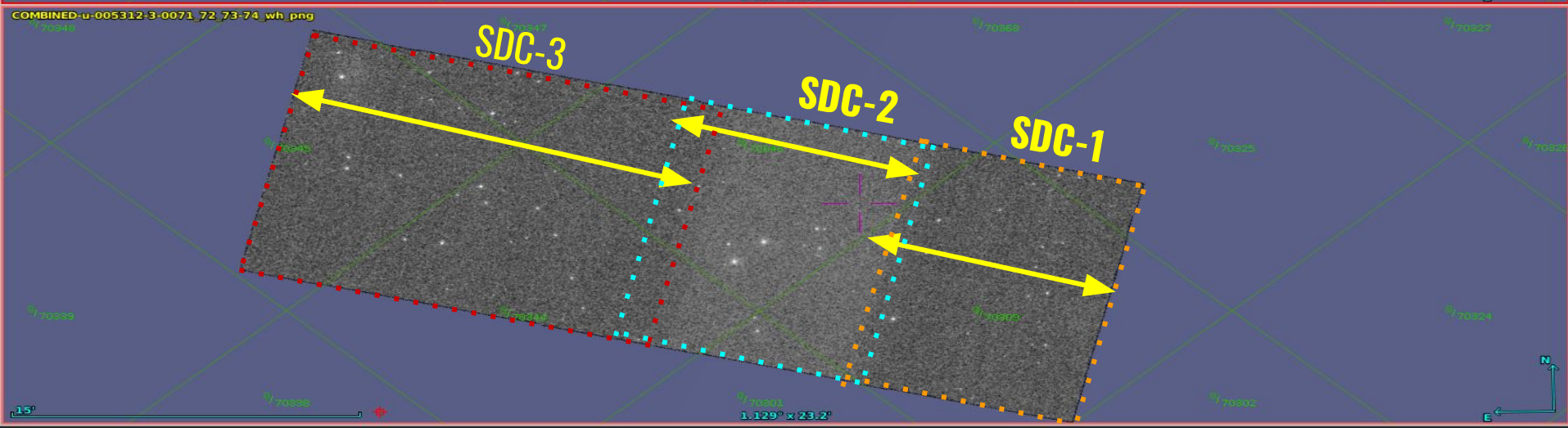


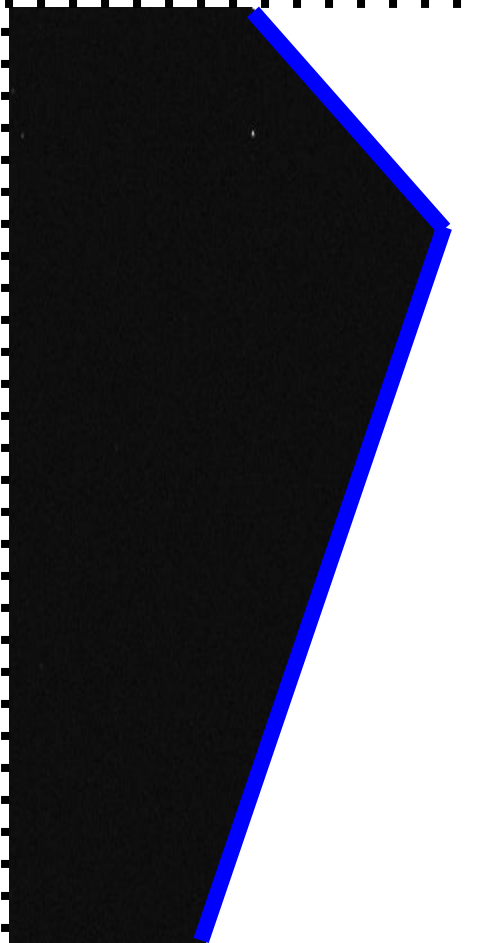
EUCLID Science Data Centers Spread Across Europe

Visualization in practice

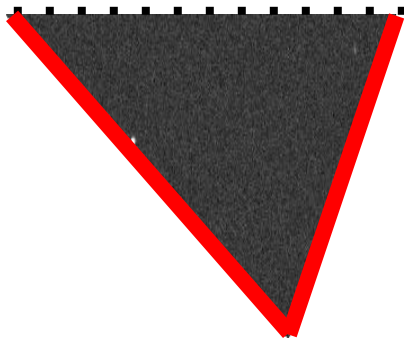
The figure consists of two panels illustrating the visualization of SDCs (Spatial Data Clusters) in practice. Both panels show a dark gray rectangular region with a cyan dashed border and a magenta crosshair, representing a specific SDC. The background is a dark blue grid with green lines and labels.

Top Panel: Shows a single SDC labeled **SDC-2** in yellow. The region is outlined by a cyan dashed border. A magenta crosshair is centered within the region. The background grid is labeled with coordinates such as 70845, 70844, 70843, 70842, 70841, 70840, 70839, 70838, 70837, 70836, 70835, 70834, 70833, 70832, 70831, 70830, 70829, 70828, 70827, 70826, 70825, 70824, 70823, 70822, 70821, 70820, 70819, 70818, 70817, 70816, 70815, 70814, 70813, 70812, 70811, 70810, 70809, 70808, 70807, 70806, 70805, 70804, 70803, 70802, 70801, 70800, 70799, 70798, 70797, 70796, 70795, 70794, 70793, 70792, 70791, 70790, 70789, 70788, 70787, 70786, 70785, 70784, 70783, 70782, 70781, 70780, 70779, 70778, 70777, 70776, 70775, 70774, 70773, 70772, 70771, 70770, 70769, 70768, 70767, 70766, 70765, 70764, 70763, 70762, 70761, 70760, 70759, 70758, 70757, 70756, 70755, 70754, 70753, 70752, 70751, 70750, 70749, 70748, 70747, 70746, 70745, 70744, 70743, 70742, 70741, 70740, 70739, 70738, 70737, 70736, 70735, 70734, 70733, 70732, 70731, 70730, 70729, 70728, 70727, 70726, 70725, 70724, 70723, 70722, 70721, 70720, 70719, 70718, 70717, 70716, 70715, 70714, 70713, 70712, 70711, 70710, 70709, 70708, 70707, 70706, 70705, 70704, 70703, 70702, 70701, 70700, 70699, 70698, 70697, 70696, 70695, 70694, 70693, 70692, 70691, 70690, 70689, 70688, 70687, 70686, 70685, 70684, 70683, 70682, 70681, 70680, 70679, 70678, 70677, 70676, 70675, 70674, 70673, 70672, 70671, 70670, 70669, 70668, 70667, 70666, 70665, 70664, 70663, 70662, 70661, 70660, 70659, 70658, 70657, 70656, 70655, 70654, 70653, 70652, 70651, 70650, 70649, 70648, 70647, 70646, 70645, 70644, 70643, 70642, 70641, 70640, 70639, 70638, 70637, 70636, 70635, 70634, 70633, 70632, 70631, 70630, 70629, 70628, 70627, 70626, 70625, 70624, 70623, 70622, 70621, 70620, 70619, 70618, 70617, 70616, 70615, 70614, 70613, 70612, 70611, 70610, 70609, 70608, 70607, 70606, 70605, 70604, 70603, 70602, 70601, 70600, 70599, 70598, 70597, 70596, 70595, 70594, 70593, 70592, 70591, 70590, 70589, 70588, 70587, 70586, 70585, 70584, 70583, 70582, 70581, 70580, 70579, 70578, 70577, 70576, 70575, 70574, 70573, 70572, 70571, 70570, 70569, 70568, 70567, 70566, 70565, 70564, 70563, 70562, 70561, 70560, 70559, 70558, 70557, 70556, 70555, 70554, 70553, 70552, 70551, 70550, 70549, 70548, 70547, 70546, 70545, 70544, 70543, 70542, 70541, 70540, 70539, 70538, 70537, 70536, 70535, 70534, 70533, 70532, 70531, 70530, 70529, 70528, 70527, 70526, 70525, 70524, 70523, 70522, 70521, 70520, 70519, 70518, 70517, 70516, 70515, 70514, 70513, 70512, 70511, 70510, 70509, 70508, 70507, 70506, 70505, 70504, 70503, 70502, 70501, 70500, 70499, 70498, 70497, 70496, 70495, 70494, 70493, 70492, 70491, 70490, 70489, 70488, 70487, 70486, 70485, 70484, 70483, 70482, 70481, 70480, 70479, 70478, 70477, 70476, 70475, 70474, 70473, 70472, 70471, 70470, 70469, 70468, 70467, 70466, 70465, 70464, 70463, 70462, 70461, 70460, 70459, 70458, 70457, 70456, 70455, 70454, 70453, 70452, 70451, 70450, 70449, 70448, 70447, 70446, 70445, 70444, 70443, 70442, 70441, 70440, 70439, 70438, 70437, 70436, 70435, 70434, 70433, 70432, 70431, 70430, 70429, 70428, 70427, 70426, 70425, 70424, 70423, 70422, 70421, 70420, 70419, 70418, 70417, 70416, 70415, 70414, 70413, 70412, 70411, 70410, 70409, 70408, 70407, 70406, 70405, 70404, 70403, 70402, 70401, 70400, 70399, 70398, 70397, 70396, 70395, 70394, 70393, 70392, 70391, 70390, 70389, 70388, 70387, 70386, 70385, 70384, 70383, 70382, 70381, 70380, 70379, 70378, 70377, 70376, 70375, 70374, 70373, 70372, 70371, 70370, 70369, 70368, 70367, 70366, 70365, 70364, 70363, 70362, 70361, 70360, 70359, 70358, 70357, 70356, 70355, 70354, 70353, 70352, 70351, 70350, 70349, 70348, 70347, 70346, 70345, 70344, 70343, 70342, 70341, 70340, 70339, 70338, 70337, 70336, 70335, 70334, 70333, 70332, 70331, 70330, 70329, 70328, 70327, 70326, 70325, 70324, 70323, 70322, 70321, 70320, 70319, 70318, 70317, 70316, 70315, 70314, 70313, 70312, 70311, 70310, 70309, 70308, 70307, 70306, 70305, 70304, 70303, 70302, 70301, 70300, 70299, 70298, 70297, 70296, 70295, 70294, 70293, 70292

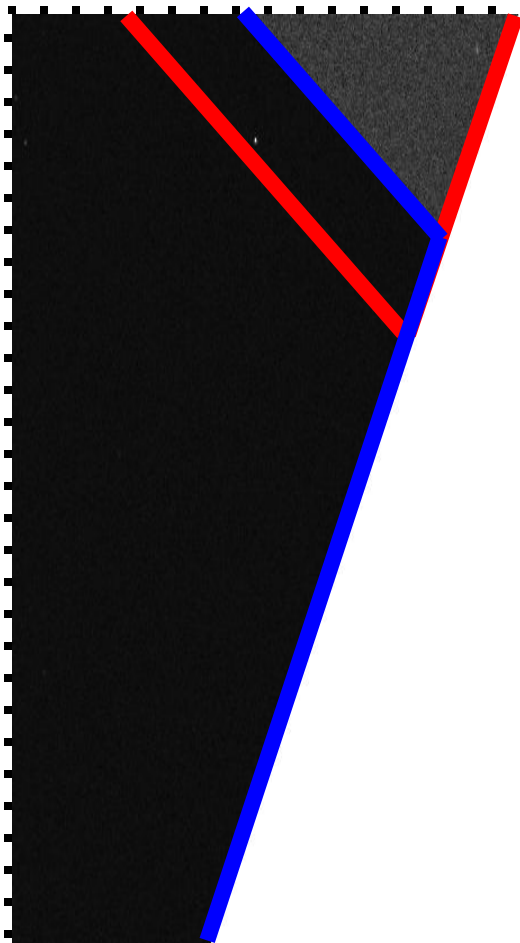




Npix281386.png

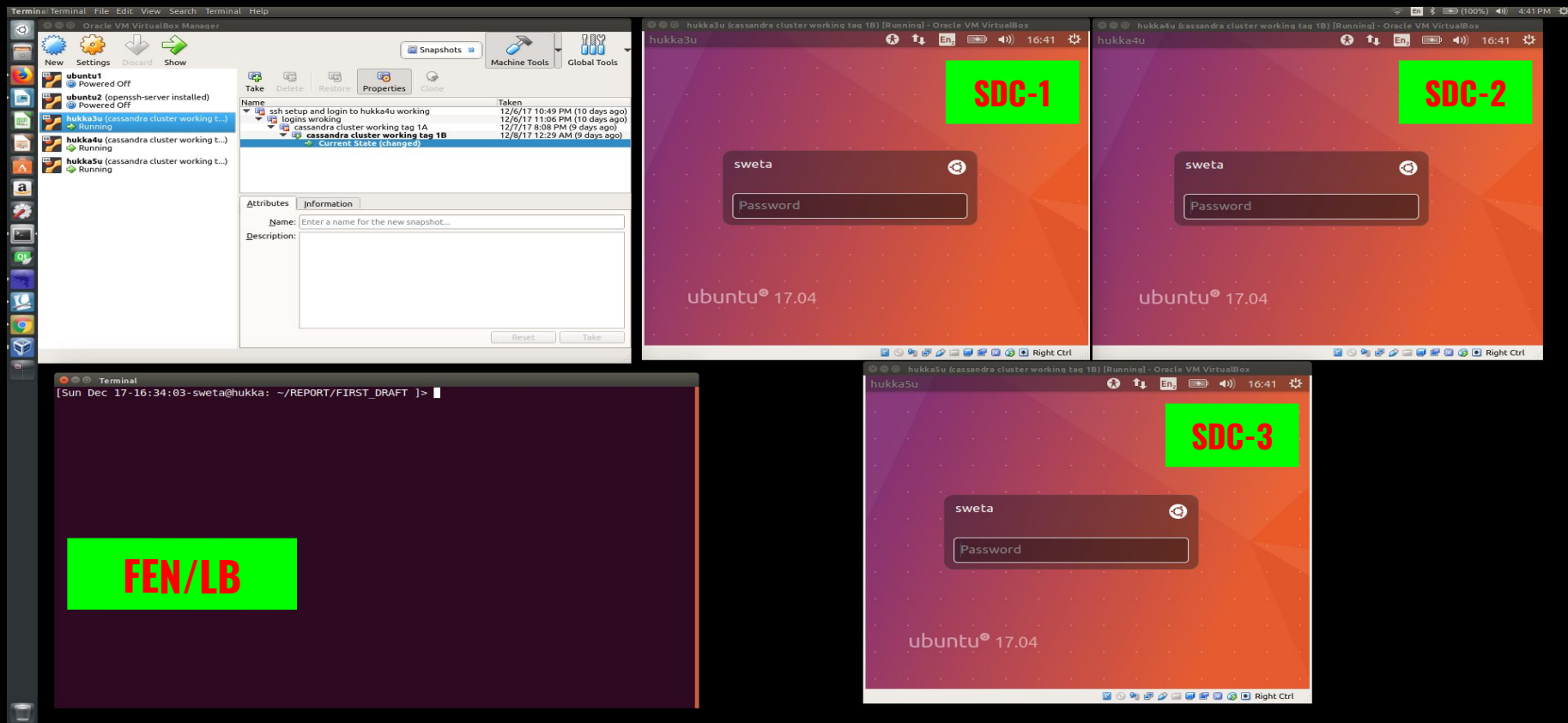


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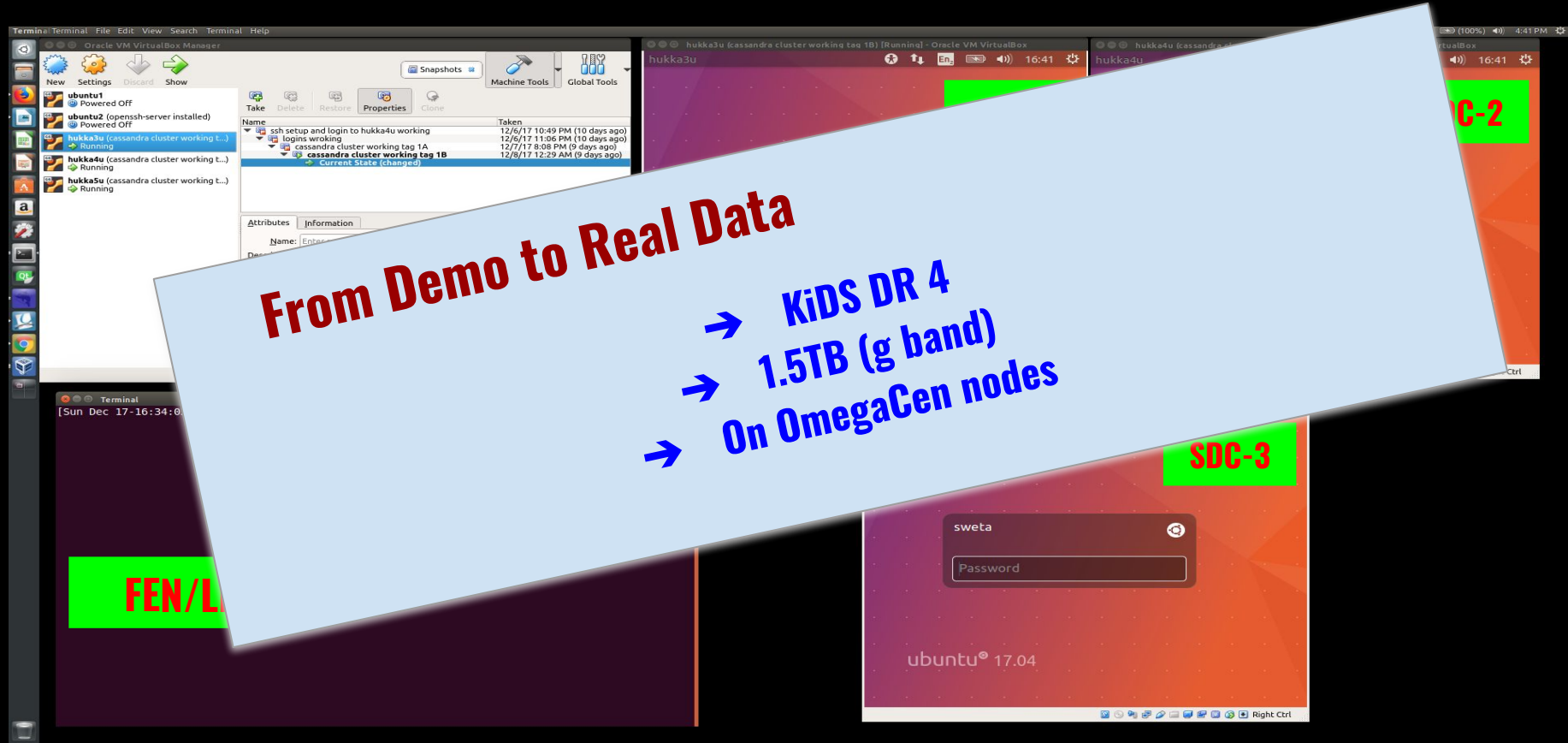


Npix281386.png

Virtual Machines as SDCs



Virtual Machines as SDCs



The screenshot displays the Oracle VM VirtualBox Manager interface. On the left, a list of virtual machines is shown: ubuntu1 (Powered Off), ubuntu2 (Powered Off), hukka3u (cassandra cluster working t...) (Running), hukka4u (cassandra cluster working t...) (Running), and hukka5u (cassandra cluster working t...) (Running). The main pane shows the 'Snapshots' view for the selected VM, displaying a tree of snapshots: 'ssh setup and login to hukka4u working' (12/6/17 10:49 PM), 'logins working' (12/6/17 11:06 PM), 'cassandra cluster working tag 1A' (12/7/17 8:08 PM), and 'cassandra cluster working tag 1B' (12/8/17 12:29 AM). The 'Current State (changed)' is indicated for the latest snapshot. A large, semi-transparent blue box with red and blue text is overlaid on the center of the image, containing the following text:

From Demo to Real Data

- KiDS DR 4
- 1.5TB (g band)
- On OmegaCen nodes

Below the blue box, there are three smaller screenshots of virtual machine desktops. The first one on the left is labeled 'FEN/L' in red text on a green background. The middle one is labeled 'SDC-2' in red text on a green background. The right one is labeled 'SDC-3' in red text on a green background. The desktops show a terminal window with the date 'Sun Dec 17-16:34:0' and a login prompt for 'sweta' with a password field. The desktop background is a red and orange geometric pattern, and the text 'ubuntu® 17.04' is visible at the bottom.

Conclusion & future steps

- Successfully developed and demonstrated distributed visualization framework for very large surveys
- Our framework works on heterogenous SDCs.
- Data size reduction using png instead of pure fits for hips survey generation has been explored
- It is also applicable to big, collaborative project like SKA
- It is being implemented on OmegaCen server nodes as SDCs
- Performance and Monitoring using ELK stack is in progress
- Further framework optimisation using caching and key value stores like cdb is being explored
- We are on our way to implement the framework for Aladinlite, as it works on the desktop version



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Thank You !



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extra



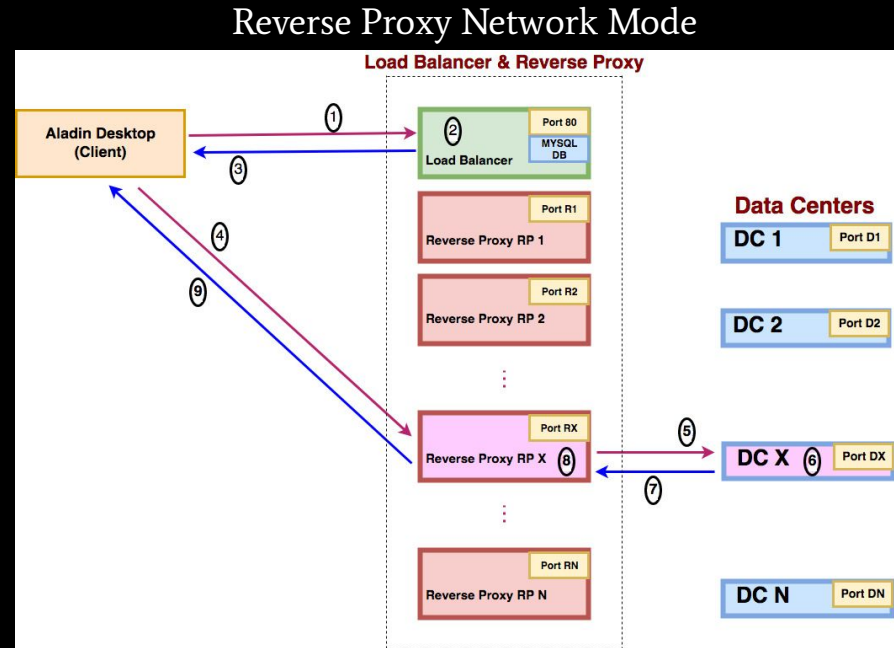
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Architecture

Distributed Network Mode



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example.hips

— index.html Moc.fits properties

■ HpxFinder

— metadata.xml Moc.fits Norder3 Norder4 Norder5 properties

■ Norder3

— Allsky

■ Dir0

— Npix68

■ Norder4

■ Dir0

— Npix274

■ Norder5

■ Dir0

— Npix1098 Npix1099

■ Norder3

— Allsky.fits

■ Dir0

— Npix68.fits

■ Norder4

■ Dir0

— Npix274.fits

■ Norder5

■ Dir0

— Npix1098.fits Npix1098_w.fits Npix1099.fits Npix1099_w.fits

HiPS Survey

- HiPS is http compliant - allows it to be accessed via http server
- Simple Hierarchical Tree structure with directories and files



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LAMP Stack

1. Linux → open source(free), reliable(virus free)
2. Apache → most popular, open source, reliable, secure, fast, http,
3. MySQL → simple, sql, open source
4. PHP → open source, server side(code executed on server side), scripting language, communicate with MySQL



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