CCDNavigator:
Get the Most on Clear Nights

WeatherNinja

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Does This Happen to You?

After an hour carefully packing my gear

Driving 5 hours to my favorite dark site

Spending an hour setting up

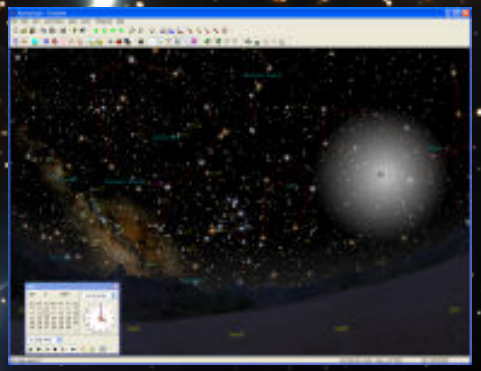
Another hour drift aligning

At last all is ready!

But I have no clue what to image!

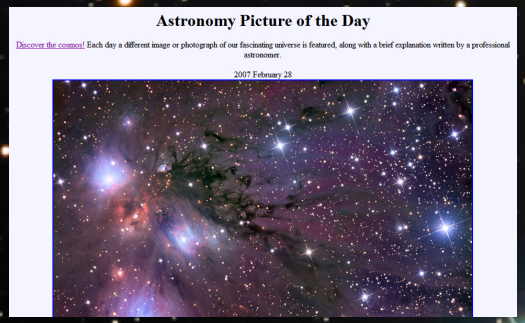
Ad Hoc Session Planning

- ***Groundhog Day***: Imaging objects you've observed visually



- ***The Haystack***: Planetarium pokey

- ***Overdose***: Tools meant for visual observers

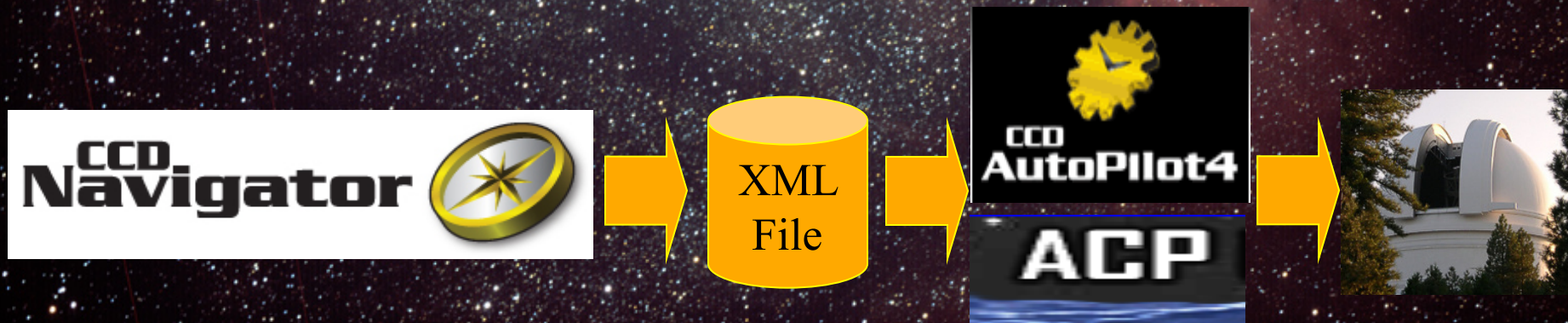


- ***"Post-it" Chaos***: Lists of objects you've seen on the Internet

- ***Out-Of-Time***: Books with pictures

Improving your Results

- *You Need:*
  - ***A Complete Plan*** – Interesting targets appropriate for your system, *exact* positioning (RA, Dec, Angle) for composition and guiding, start/stop times, LRGBH sequences, binning and exposures, guidestar selection and exposures
  - ***Automation***– Flats, darks, bias frames, precision slews, focusing management, autoguider control, frame acquisition, weather monitoring, optimization tools, flexible, robust and reliable



A Complete Plan

- ***When*** to have a ***session***
- ***Interesting*** objects that are ***available*** the night of the session
- How ***long*** they are available for imaging
- How they will ***appear*** through ***your*** system
- Target ***order*** and exactly ***when*** to start and stop imaging each
- An optimal LRGBH ***sequence*** plan for ***each*** target
- What ***guidestar*** to use and ***position/angle*** for the telescope/camera
- What autoguider ***exposure*** to use for each ***filter***

BETTER KNOW BEFORE YOU GO!

Choose Interesting Targets

CCD Navigator

568 Candidates Available for Tuesday 4/16/2013 at Pocono Mtns

3C273 ABELL194 ABELL671 ABELL1656 ABELL2218 ABELL2666 ARP248 ARP314 ARP322 B72 B86

CED90 IC10 ... IC417 IC434

IC443 IC444 ... IC2162 IC2177

IC4592 IC4601 ... LBN438 M1

M2 **M3** ... M12 M13

M14 M15 ... M32 M33

M35 M37 ... M57 M58

M61 M63 ... M78 M79

M74

Preview SIMBAD In FOV TheSkyX ClearSkyChart

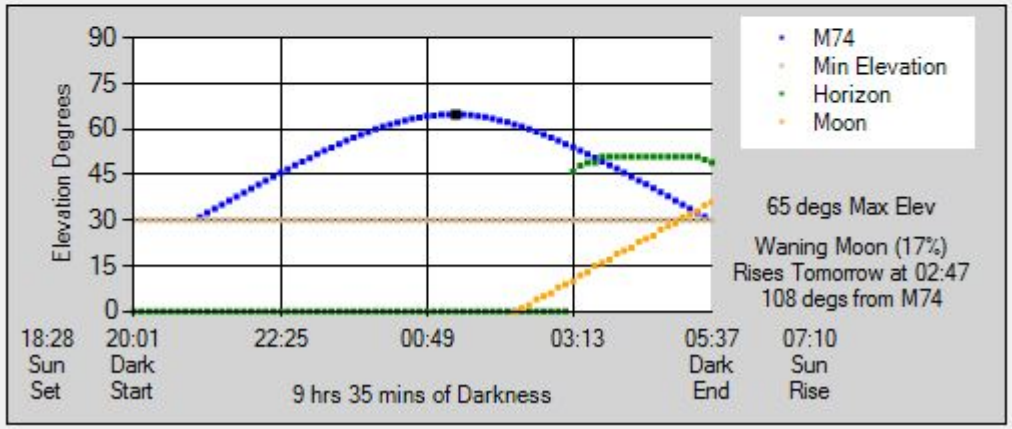
Image courtesy of Rob Gendler

Aliases: NGC628;
Description: Sc
Constellation: Psc
Opposition: 10/18/2012 Available for 8 hrs 29 mins

Type	GX	From	21:03
Size	10.5'	Until	05:33
Mag	9.1	Transit	01:18
RA	01:36:41.6		
DEC	+15:46:59.9		
PA	0.0		

Add To Favorites

Add To Session



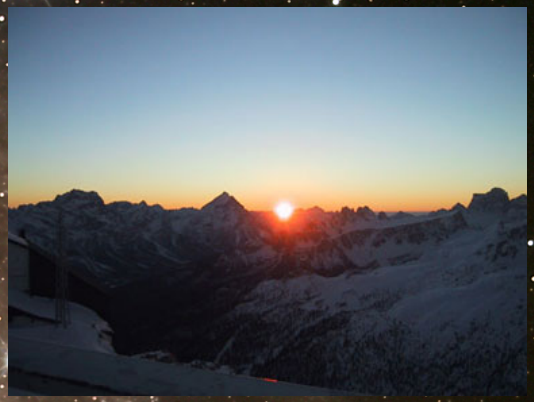
When To Have A Session:

- Darkness and Imaging

From Sunset…

When does it get "dark"?

…to Sunrise



Some definitions:

- Sunset / Sunrise = Sun's upper edge is at the horizon
- Civil Twilight = Sun's center is 6 degrees below horizon
- Nautical Twilight = Sun's center is 12 degrees below horizon
- Astronomical Twilight = Sun's center is 18 degrees below horizon

Prefer to know the exact start and end of Astronomical Twilight, this varies by latitude but ~1.5 hrs after Sunset until 1.5 hrs before sunrise

When To Have A Session:

Dates of New Moon are a good time for a session but equally good dates exist

Moon is Not seen during astronomical darkness

Sets before the start of darkness

- Rises after end of darkness

Month														Nights
Jan-10	9	10	11	12	13	14	15	16	17	18	19	20	21	10
Feb-10	8	9	10	11	12	13	14	15	16	17	18	19	20	9
Mar-10	9	10	11	12	13	14	15	16	17	18	19	20	21	9
Apr-10	8	9	10	11	12	13	14	15	16	17	18	19	20	9
May-10	8	9	10	11	12	13	14	15	16	17	18	19	20	9
Jun-10	6	7	8	9	10	11	12	13	14	15	16	17	18	9
Jul-10	5	6	7	8	9	10	11	12	13	14	15	16	17	10
Aug-10	4	5	6	7	8	9	10	11	12	13	14	15	16	10
Sep-10	2	3	4	5	6	7	8	9	10	11	12	13	14	10
Oct-10	1	2	3	4	5	6	7	8	9	10	11	12	13	10
Nov-10	30	1	2	3	4	5	6	7	8	9	10	11	12	9
Dec-10	30	1	2	3	4	5	6	7	8	9	10	11	12	9

Dates of total darkness are ***not*** centered on New Moon!

Target Availability

Availability depends on:

- Session Date
- Beginning and ending of darkness
- Minimum elevation angle crossing times
- Example: On 4/14/2010, darkness lasts from 9:32 pm until 4:48 am, M95 rises at 3:31 pm, ascends to 30 degrees at 6:05 pm, transits at 10:23 pm, descends to 30 degrees at 2:41 am, sets at 5:02 am.
- ***Available for 5 hr 8 min from 9:32 pm until 2:41 am***

Our plan should be driven by target availability

Planetarium programs give rise, set & transit times but you need elevation crossing times to calculate imaging availability

Target Order

Based on availability

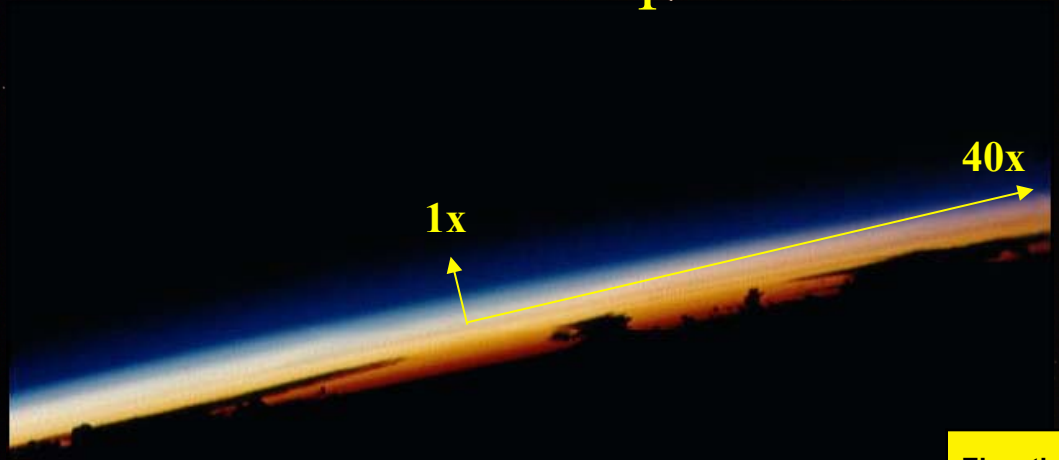
- The target(s) with the earliest starting availability should be imaged first

- If two or more targets have the same starting availability, the one(s) with the earliest ending availability should be imaged first

- If two or more targets have the same starting and ending availability, the one(s) with the earliest transit should be imaged first

Atmospherics

How much atmosphere is in our optical path? So what?



$$\text{Air Mass} = \frac{1}{\sin(\text{el}) + 0.025\, e^{-11 \sin(\text{el})}}$$

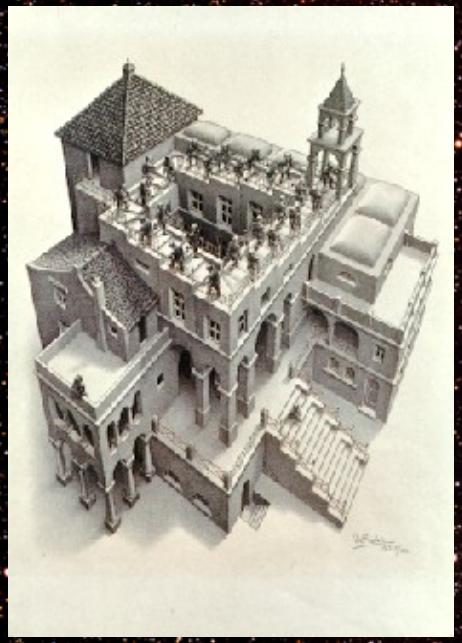
Greater Air Mass:
- Degraded resolution
- Greater color extinction

- Choose a Minimum Elevation Angle
- Elevation Priority (high to low) is LBGR
  - Maximizes L resolution
  - Minimizes color extinction
- Determines start time and frame order

Elevation	Air Mass	Seeing	Red Extinction	Green Extinction	Blue Extinction
90	1.00	2.00	0.0%	0.0%	0.0%
85	1.00	2.01	0.0%	0.1%	0.1%
80	1.02	2.02	0.1%	0.2%	0.3%
75	1.04	2.05	0.3%	0.6%	0.8%
70	1.06	2.09	0.5%	1.0%	1.4%
65	1.10	2.15	0.9%	1.7%	2.4%
60	1.15	2.23	1.3%	2.5%	3.5%
55	1.22	2.33	1.8%	3.6%	5.0%
50	1.31	2.47	2.5%	5.0%	7.5%
45	1.41	2.67	3.4%	6.8%	9.7%
40	1.56	2.94	4.6%	9.2%	13.2%
35	1.74	3.35	6.3%	12.5%	18.0%
30	2.00	4.00	8.5%	17.2%	24.9%
25	2.36	5.15	11.8%	24.2%	35.6%
20	2.92	7.56	17.0%	35.6%	53.5%
15	3.84	14.34	26.3%	57.4%	89.2%
10	5.64	49.82			
5	10.34	-			
0	40.00	-			

LRGB Acquisition

CCDNavigator provides two methods:



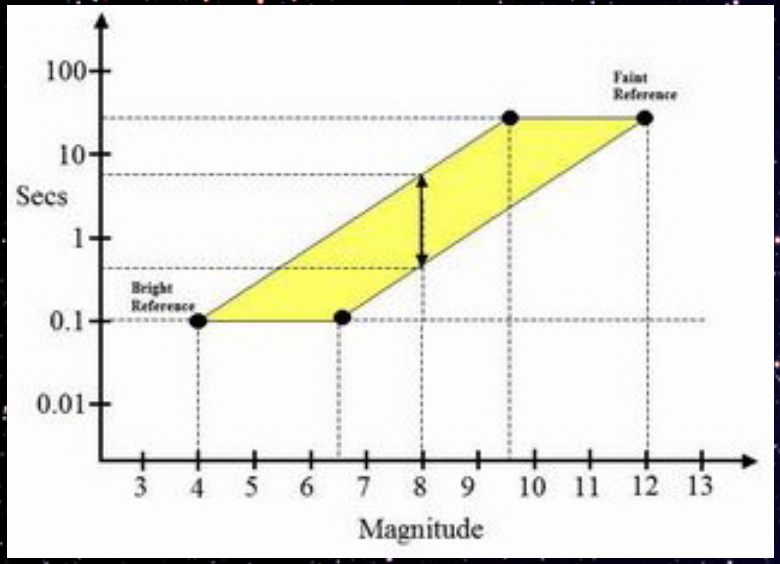
- **"Staircase" sequencing**
  - Maximizes L resolution, minimizes B extinction
  - Centered on transit time of target

- **"Shuffle" Sequencing**
  - Cycles through LRGB filters
  - Ensures getting some data

(LRGB)(LRGB)(LRGB)(LRGB)….

(LLLRGB)(LLLRGB)(LLLRGB)….

Autoguider Exposure



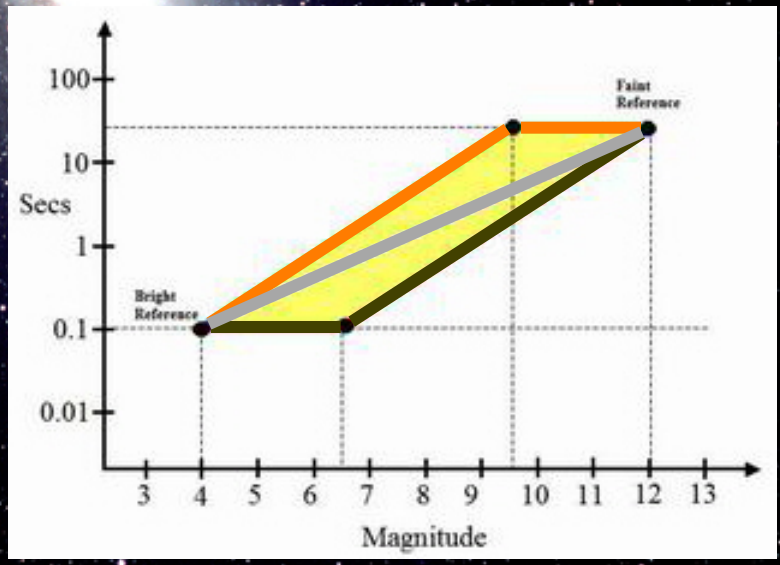
Two reference values specify a guiding "Window". Any point inside the parallelogram provides guidestar SNR / ADU and guiding comparable to the references

Three guider exposure "Strategies"

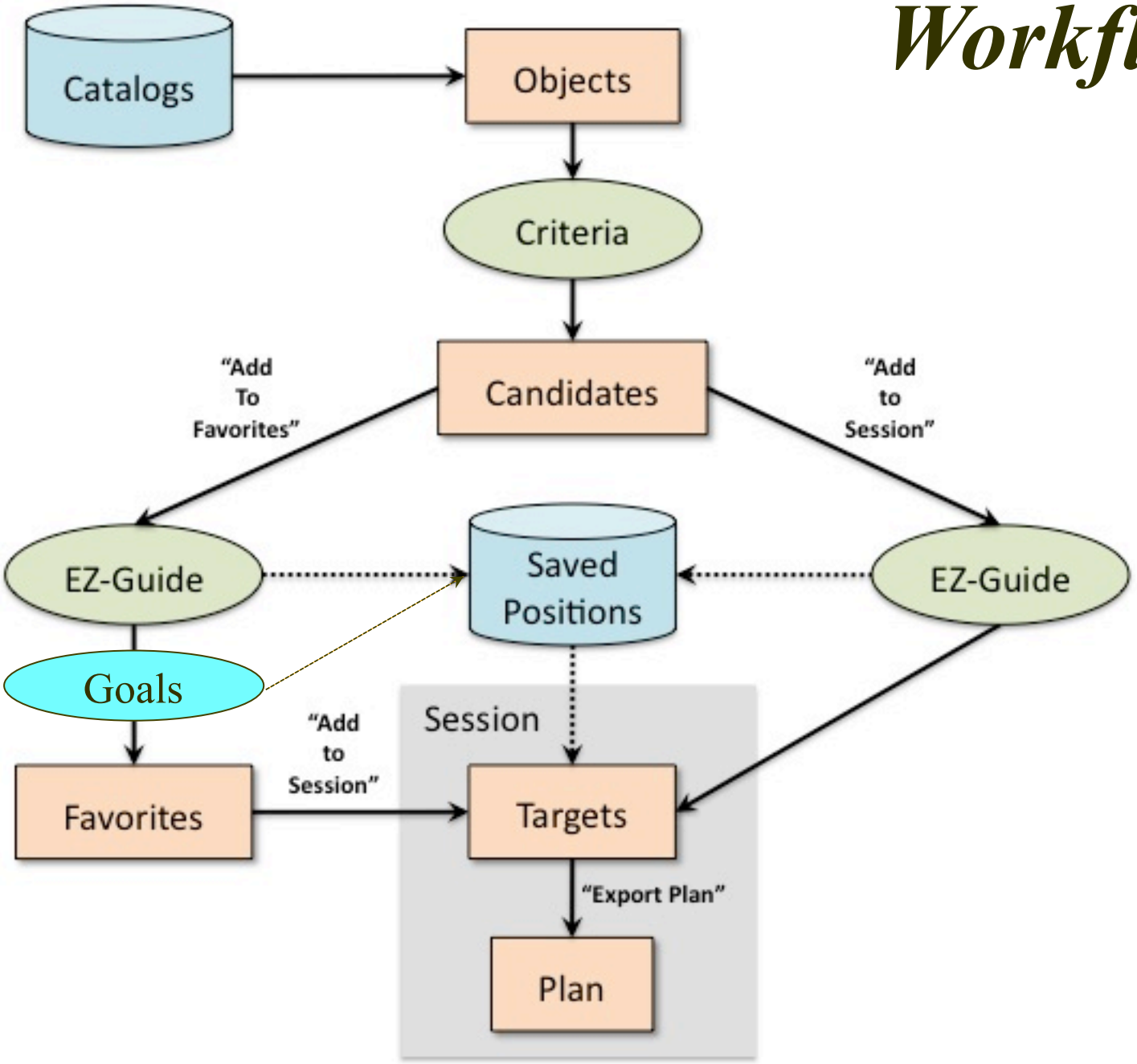
- Brown is "Shortest" exposure
- Orange is "Longest" exposure
- Gray is "Medium" exposure

Each filter managed separately for self guided cameras

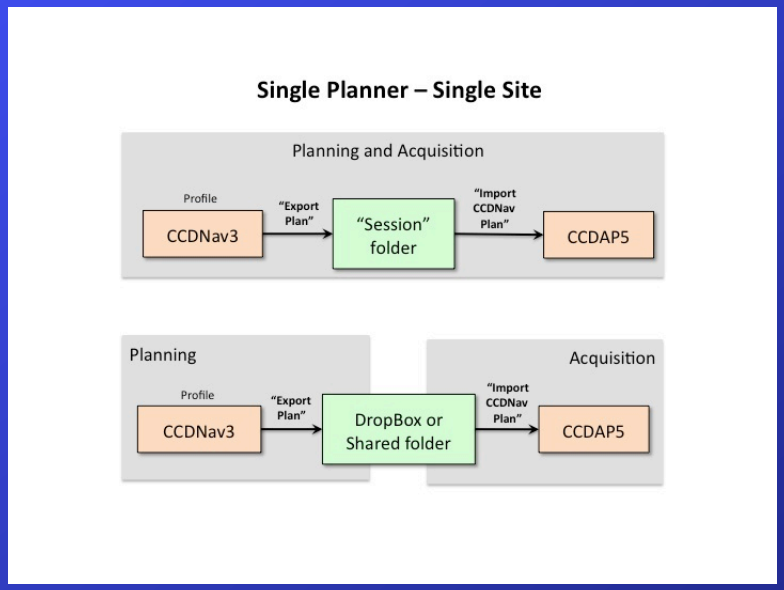
Mag	L	R	G	B
4.0	0.1	0.3	0.3	0.5
12.0	15.0	20.0	20.0	25.0

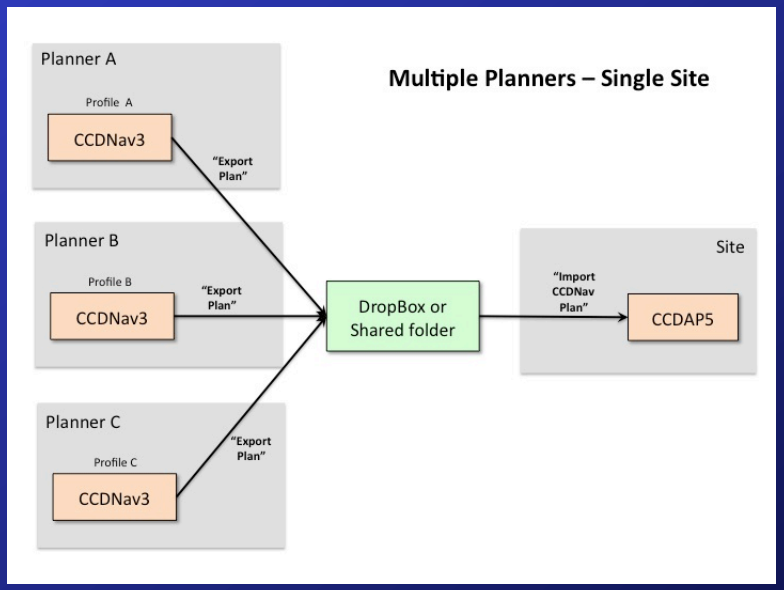


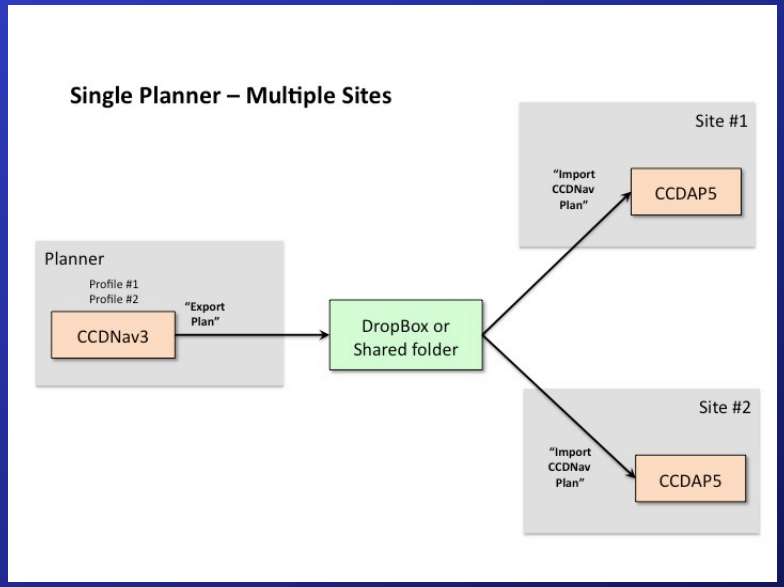
Workflow

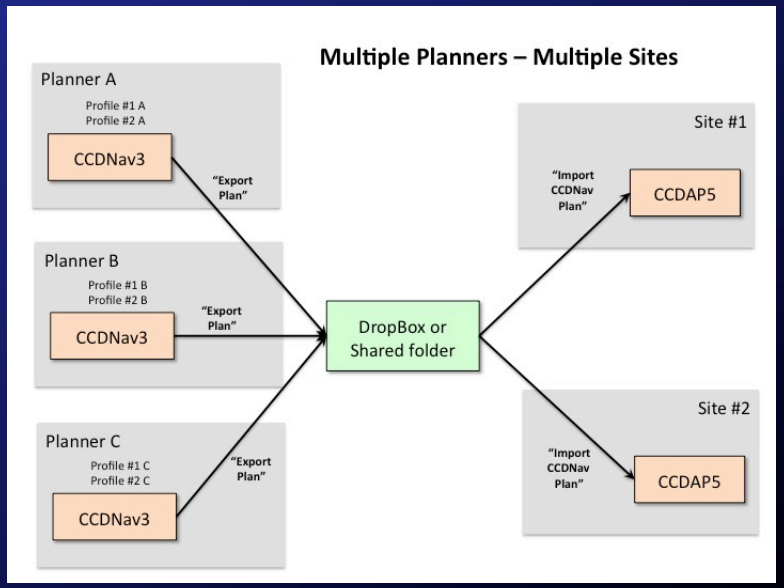

Catalogs
Objects
Criteria
Candidates
"Add To Favorites"
"Add to Session"
EZ-Guide
Saved Positions
EZ-Guide
Goals
Session
"Add to Session"
Favorites
Targets
"Export Plan"
Plan

Site Administration









CCDNavigator Demo

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