Anatomy of an Imaging System

What toys do you need on a Mac /Linux?

Session 3

Anatomy of an Imaging System
3 separate sessions:

1. Description of the hardware and software generally
2. PC software integration and demo
3. Mac/Unix Raspberry Pi software integration and demo

MAC and Linux software

There are *fewer* software packages for OS X and Linux systems…

- Planning & Observation:
- AstroPlanner
- Observatory
- Cartes du Ciel
- SkySafari 6 Pro

- Planetarium & Scope Control:
- CloudMakers AstroTelescope
- Stellarium
- KStars with EKOS
- Astroberry Server (RPi only)
- SkySafari 6 Pro
- Starry Night
- TheSkyX
- AstroGrav

- Capturing & Processing:
- ASTAP
- Astro Pixel Processor
- Stark Labs Nebulosity
- PixInsight
- CloudMakers AstroImager
- CloudMakers AstroDSLR
- CloudMakers AstroGuider
- PHD2 Guiding
- Open Astro Project
- Lynkeos
- Keith's Image Stacker
- StarTools
- FireCapture
- SiriL
- Planetary Imager
- ASTAP
- CCDciel
- StarStaX
- Startrails Creator
- AstroImageJ

- Utilities:
- CloudMakers FITS Preview
- CloudMakers INDI Control Panel
- CloudMakers INDI Server
- CloudMakers Astrometry
- Collimation Aid
- Darklight
- SER Player
- Nightlight
- QFitsView
- PHD2 Log Viewer

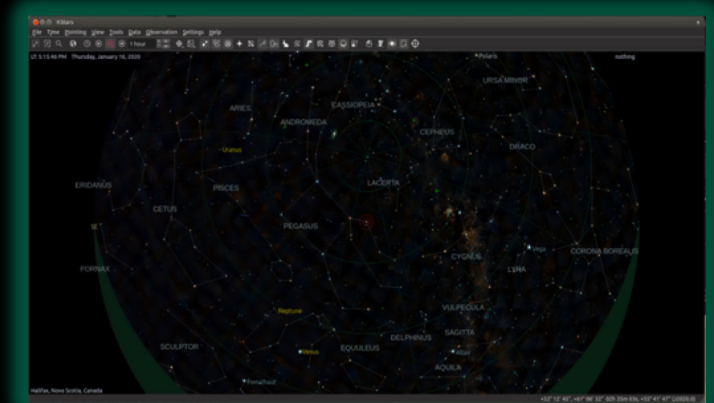*https://www.macobservatory.com/mac-astronomy-software/
Also https://www.macobservatory.com/blog/2020/3/29/how-to-connect-your-telescope-to-your-home-network-with-kstarsekos

MAC and Linux software

We'll focus on – Open-source **KStars/Ekos** (Windows / OS X / Linux) which integrates:

- ✓ Planetarium software
- ✓ Telescope / mount control drivers
- ✓ Camera control drivers
- ✓ Support for electronic focusers
- ✓ Internal Guiding as well as supporting Phd2
- ✓ Internal Plate solving, solve image and slew, load and slew, as well as ASTAP
- ✓ Polar alignment
- ✓ 'Fits' Image format storage and auto-stretch viewing
- ✓ Network access between local and remote systems for remote imaging
- ✓ Observation planner to identify viewable imaging targets for the session
- ✓ Automatic scheduler – tracking, meridian flip, focusing, alignment, guiding, constraints
- ✓ Mosaic imaging
- ✓ Weather alerts / actions
- ✓ Dome Control
- ✓ Typically, all indi device drivers are installed for you.
- ✓ Developmental Indihub agent for sharing https://indihub.space
- ✓ *…sorry, no social media integration [yet]* ☺

INDI

HOW IT ALL WORKS

INDI Architecture
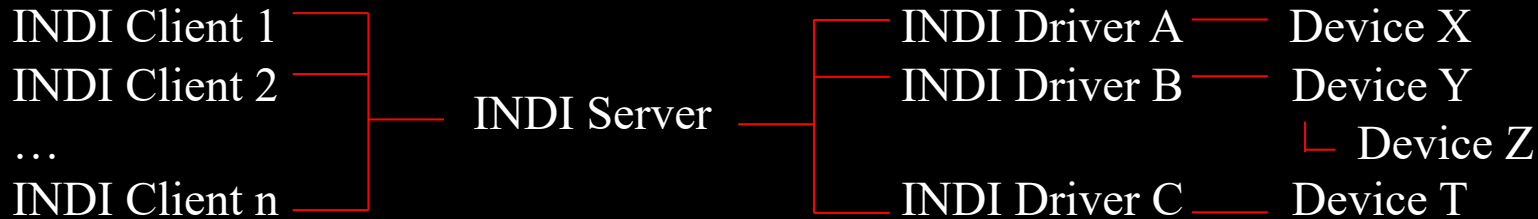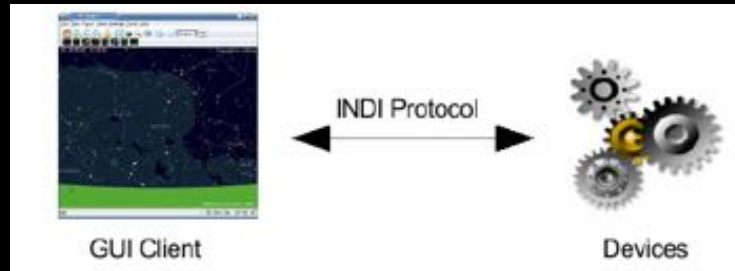
GUI Client — INDI Protocol — Devices

INDI Client 1
INDI Client 2
…
INDI Client n
— INDI Server —
INDI Driver A — Device X
INDI Driver B — Device Y
            └ Device Z
INDI Driver C — Device T

| Client Processes | INET sockets | Server Process | UNIX pipes | Driver Processes | Hardware Devices |

or entirely within a single machine

INDI - Instrument-Neutral-Distributed-Interface

Open source - Released under the GNU Lesser General Public License LGPL v2

Cross Platform - implementation of the INDI XML based protocol for POSIX operating systems. Currently, Linux, BSD, and OSX are supported. INDI Server for Windows is available separately natively on Windows.

Client agnostic - Clients learn the properties of a Device at runtime using introspection. This decouples the device driver implementation from clients. The device driver may be updated completely independent of the client.

Distributed control - With INDI server/client architecture, you can communicate with devices either locally or remotely transparently. INDI accommodates intermediate servers, broadcasting, and connection topologies ranging from one-to-one on a single system to many-to-many between systems of different genre.

INDI Server for Windows

- *INDI Server for Windows* is a wrapper and INDI server for ASCOM drivers. http://www.cloudmakers.eu/windi/

- A separate installer is available for this.

INDI supports many devices

- 19 Telescopes

- 18 Cameras

- 27 Focusers

- 10 Filter wheels

- 12 Auxiliary devices - spectrographs, sensors, encoders, switches, motor, radio & photon detectors, rotators, adaptive optics, power control, GPS, SQM...etc.

- 6 Dome controllers

- 8 Weather Stations

✓ Documentation for adapting/writing your own driver if you are building your own hardware

INDI supports many clients

Kstars, Ekos, KStars Lite, IPARCOS, Cartes Du Ciel, CCDCiel, DCD, INDI For Java, PHD2, jINDI, iINDI, Xephem, GoQat, EqmodGui, INDI Web Manager App, INDI starter, indiprop, PixInsight, HNSky, Stellarium, MoonPanoramaMaker , ZWO ASIAIR, AstroPhoto Plus

- For more details: https://indilib.org/about/clients.html

How KStars/Ekos interact

- **KStars** is free, open source, cross-platform Astronomy Software. It provides an accurate graphical simulation of the night sky, from any location on Earth, at any date and time. The display includes up to 100 million stars, 13,000 deep-sky objects, all 8 planets, the Sun and Moon, and thousands of comets and asteroids. In addition, it provides tools to perform many astronomical calculations, an observation planner, and lots of information and resources to help you explore the universe. KStars includes Ekos (below).

- **Ekos** is an advanced cross-platform observatory control and automation tool with focus on Astrophotography. It is based on a modular extensible framework to perform common astrophotography tasks. This includes accurate GOTOs using astrometry solver, ability to measure and correct polar alignment errors , auto-focus & auto-guide capabilities, and capture of single or stack of images with filter wheel support.

Kstars/Ekos Connectivity

KStars.app

- **Ekos** uses its internal guiding software for guiding to reduce star trails or may optionally use Phd2 as the guiding software with additional features. Both support dithering.

- **Ekos** has 3 plate solving approaches, ASTAP, astrometry.net locally, or on-line astrometry.net (more robust solving).

- Kstars/Ekos runs on many small Iot (Internet of things) devices e.g. Raspberry Pi, Odroid-N2, Intel NUC and many flavours of unix.

Ubuntu   **Fedora**   **Gentoo**   **Mac OSX**

Arch

Workflow – how does it really work

- Check *ClearDarkSky* or *Astropheric* for suitable conditions
- Setup tripod/mount, attaching camera, guide camera, computer to control /capture images, dew heaters, battery (GPS) (*drive back to Halifax for the counterweight you've forgotten*)
- Initial rough Polar Alignment (perhaps using polar scope) or PoleMaster
- Start the mount - setting date/time/position/Time Zone (*-4 works much better than 4*)
- Connect to hotspot on computer (*drive back to Halifax for password you've forgotten*)
- Adjust focus using Bahtinov mask or focuser
- Align mount using reference stars, add calibration stars
- Refine polar alignment using southern star near meridian
- *Accidentally kick tripod or loose power and start all over again - optional*
- Slew to target or plate solve an existing image to slew to a previous target
- Plate solve to provide World Coordinate System (WCS) info
- Set up guiding (e.g. Phd2) including dithering.
- Configure capture software to take a sequence of exposures or use a session plan
- (Remember to take dark frames typically at the end of the session)
- *Astropheric was wrong - Watch clouds roll in - optional*

Sometimes the results can be promising

Demo of KStars