Weather Technology in the Cockpit (WTIC) Program
Remote Oceanic Meteorological Information Operational (ROMIO) Demonstration
CDO/CTH system engineering overview

This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

Dan Megenhardt

National Center for Atmospheric Research

NCAR – WTIC Industry Meeting - May 24th, 2022

NCAR | RESEARCH APPLICATIONS LABORATORY

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Objectives

This presentation is meant to be an overview of the software release documentation that is included in the Technology Transfer package.

To provide a basic understanding of

- Hardware recommendations
- Input data requirements
- Output data formats
- Processing steps
- Robustness of the system

Hardware recommendations

The following system specifications are based on hardware that was used for testing the system and are considered to be minimum requirements:

- Dual E5530 Xeon processors (2.4GHz, 4 cores, 8M cache)
- 24GB, 1333MHz RAM
  - 48GB Recommended
- 1TB (stores ~7 days of data) of disk space
  - Approximately 150GB per day

Linux OS required

Software builds were tested on four different Linux Operating Systems:

- Debian GNU/Linux 9 (stretch)
- Debian GNU/Linux 10 (buster)
- CentOS Linux 7 (Core)
- Red Hat Enterprise Linux 8.3 (Ootpa)

Input Data Requirements

Model

Global Forecast System (GFS) 0.25 degree Global forecast grids

Required fields

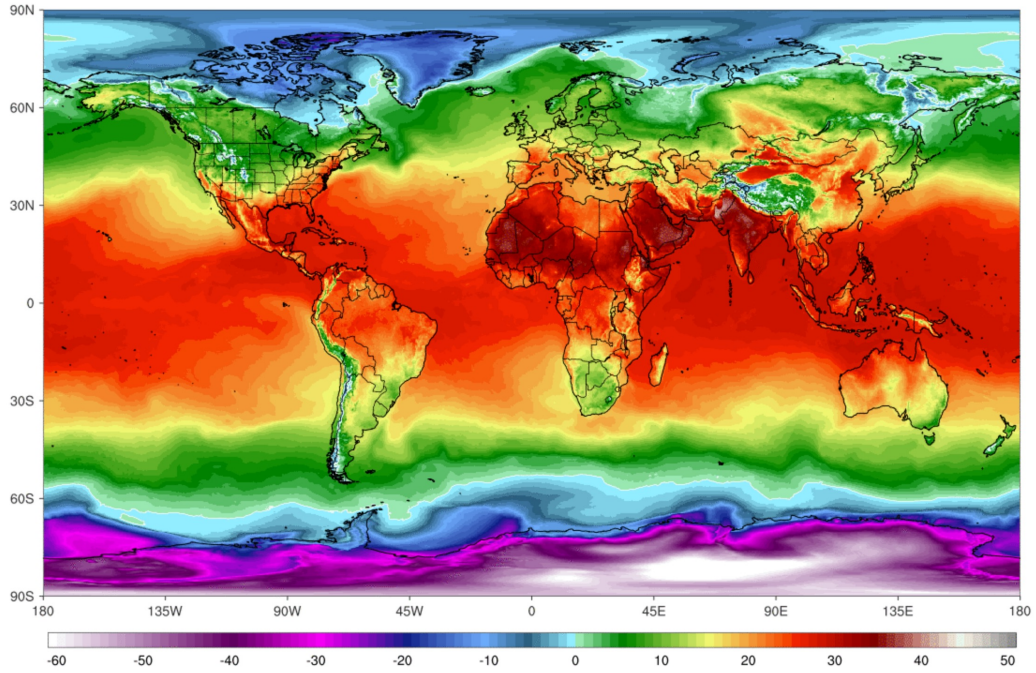
- Isobaric Surface Heights in geopotential meters (gpm, 3-D field)
- Tropopause Height in geopotential meters (gpm, 2-D field)
- Isobaric Surface Temperature (degrees Kelvin, 3-D field)

6 hour update

2 hour latency

Suggested forecast lead times

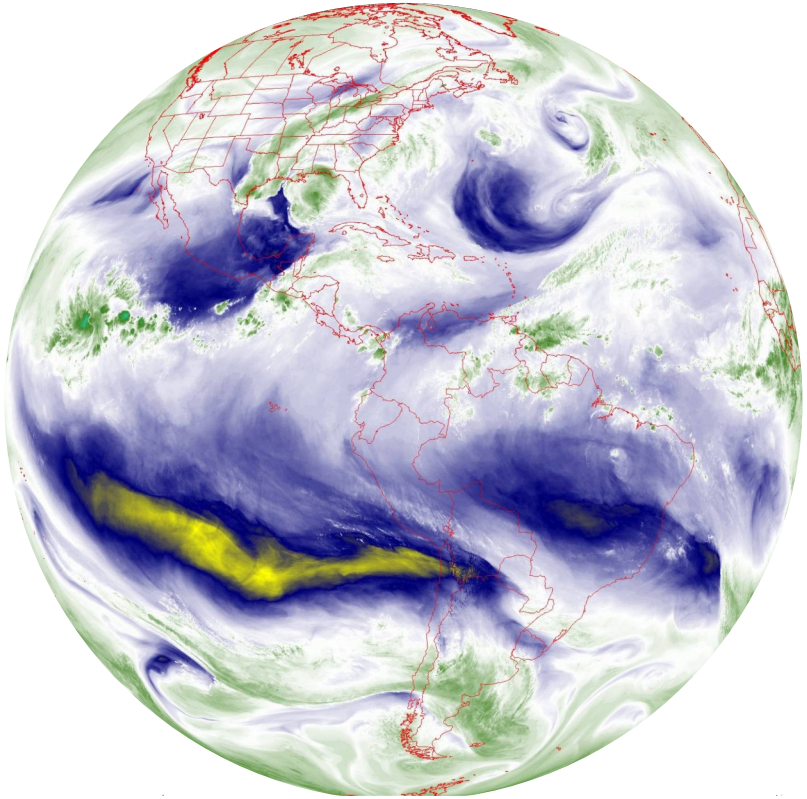
- 0, 3, 6, 9, and 12 hour



Input Data Requirements

Satellite Imager data

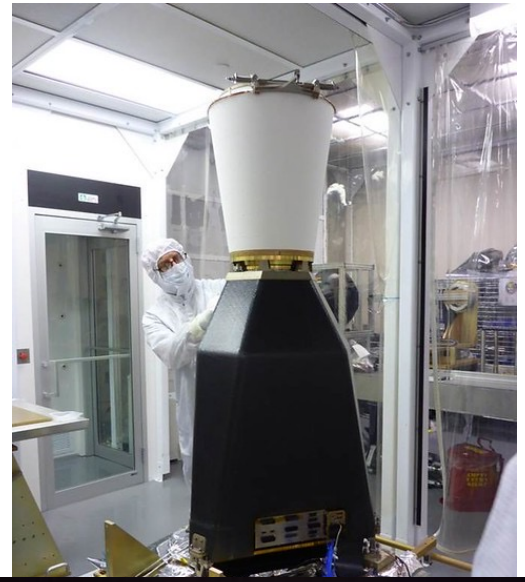
- 6.2 micron, "Upper-Level Tropospheric Water Vapor"
- 11.2 micron, “IR Longwave Window Band”
- ROMIO
  - GOES-East Full Disc (10 minute updates)
  - GOES-West Full Disc (10 minute updates)
    - GOES-18 to replace GOES-17 in early 2023
  - Himawari Full Disc (10 minute updates)



Input Data Requirements

Lightning data

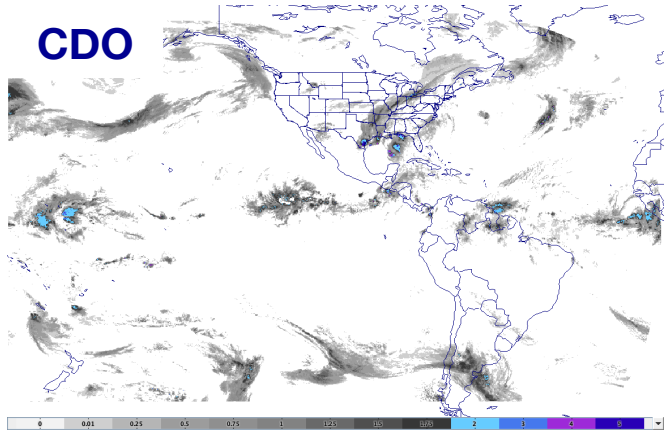
- Geostationary Lightning Mapper (GLM)
  - Available on GOES-East and Goes-West
  - Coverage up to 52 deg N lat
  - 70-90% flash detection day and night
  - 20 sec product latency
- Ground-based Lighting Network Data
  - Coverage at higher latitudes
  - Needed to cover Himawari domain

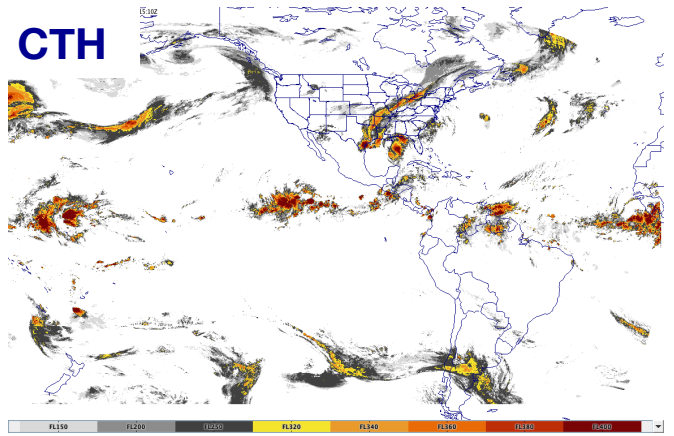


Output Data Formats

Gridded data

- Cloud Top Height (CTH)
  - GRIB2
- Convective Diagnosis Oceanic (CDO)
  - GRIB2

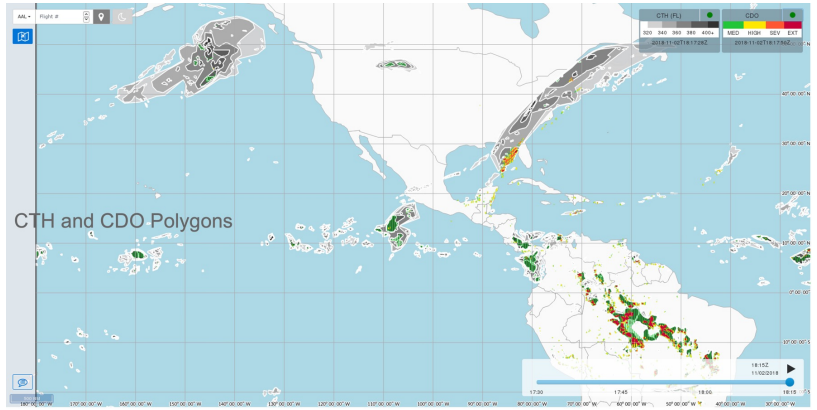




Object data (XML format)

- CTH polygons
- CTH missing data polygon
- CDO polygons
- CDO missing data polygon
- Maximum Echo Top point data

ROMIO Viewer with CDO/CTH Products

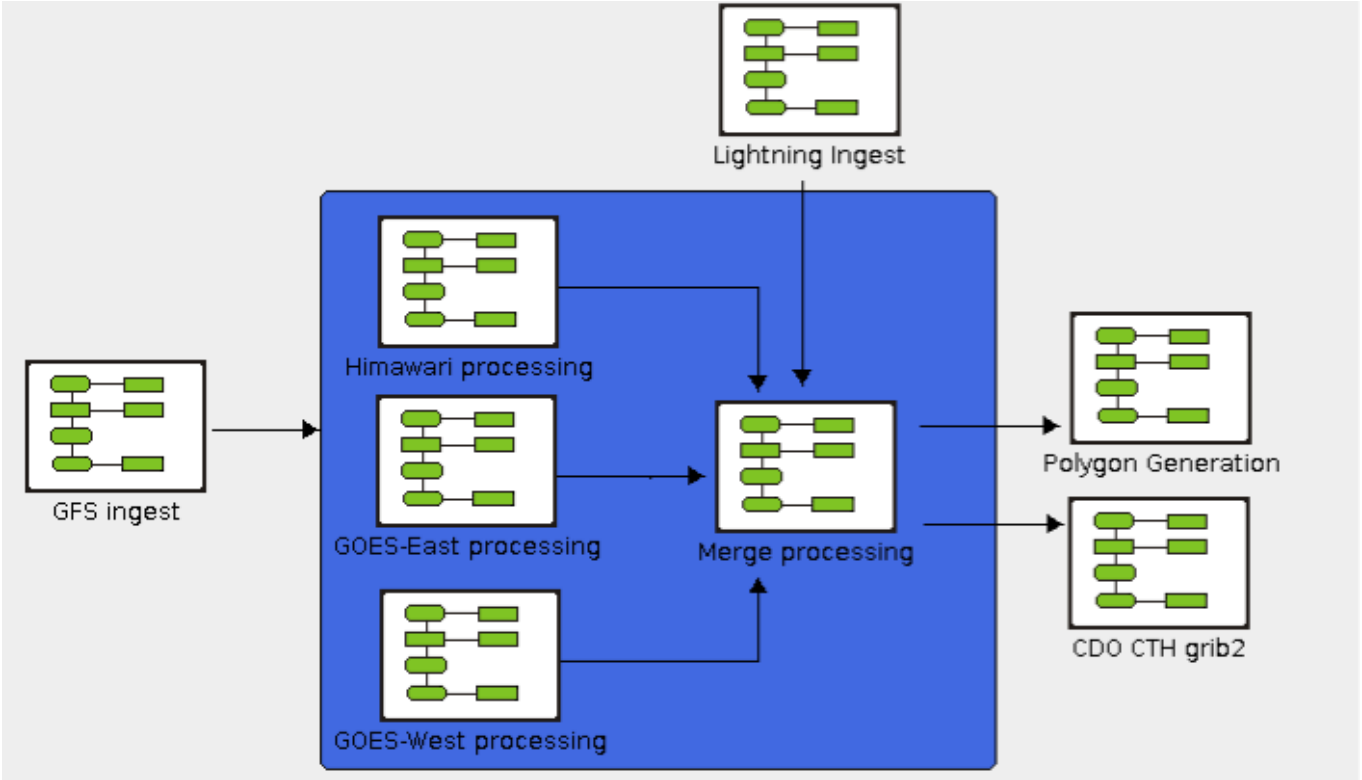


Processing Steps

This system is comprised of over 100 processes

Each process groupings contains multiple steps.

All processes are running and waiting for new data to arrive.



https://projects.ral.ucar.edu/ocnd/sysview/ocn4/CDO-CTH.html

Processing Steps

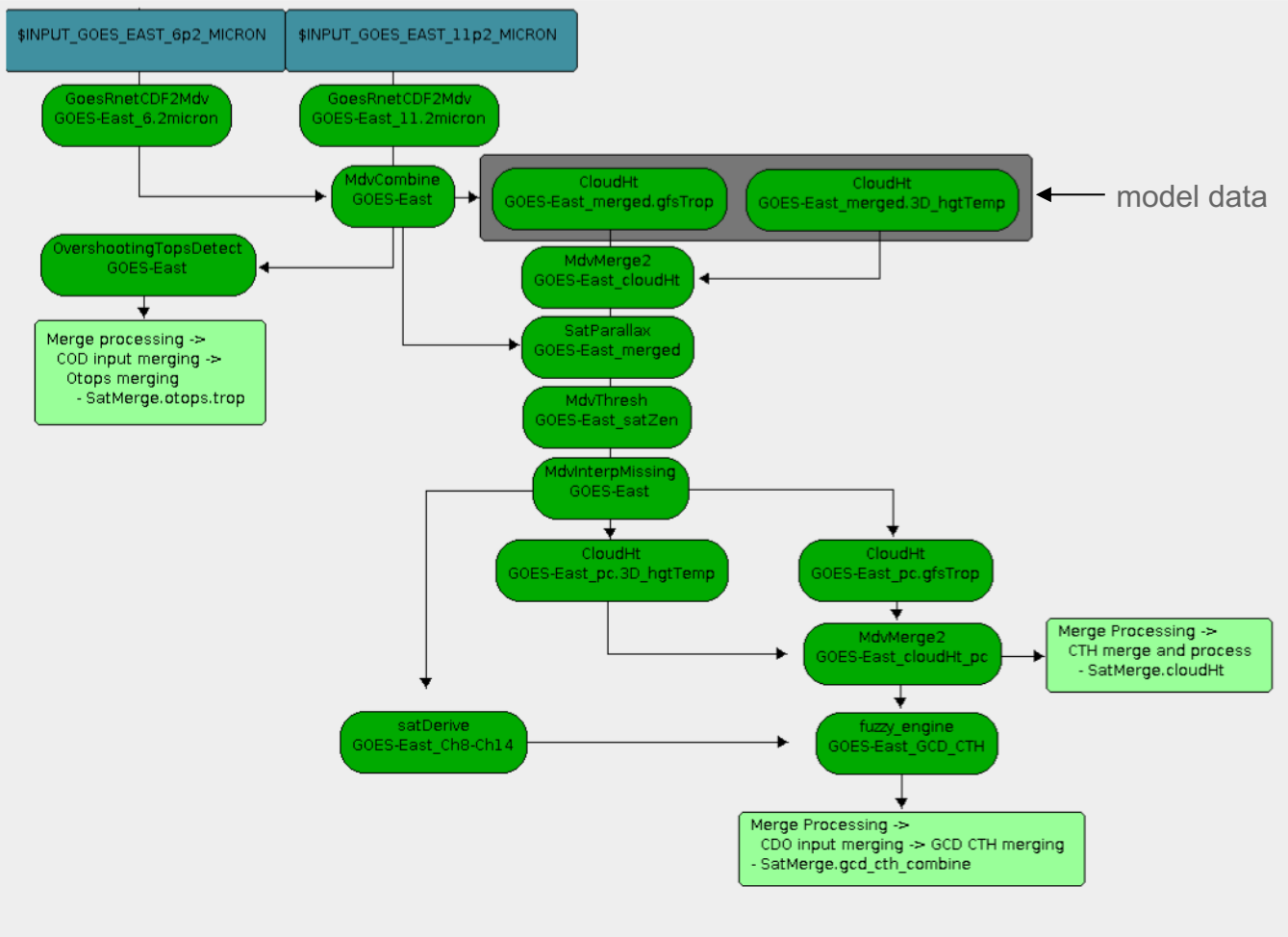
GOES-West processing is slightly different due to the cooling system issue.

Himawari requires an extra processes to calculate the satellite zenith angle.

Model data required to calculate cloud heights.

Global Convection Diagnosis (GCD)

GOES-East processing (15 processing steps)



https://projects.ral.ucar.edu/ocnd/sysview/ocn4/CDO-CTH.html

Processing Steps

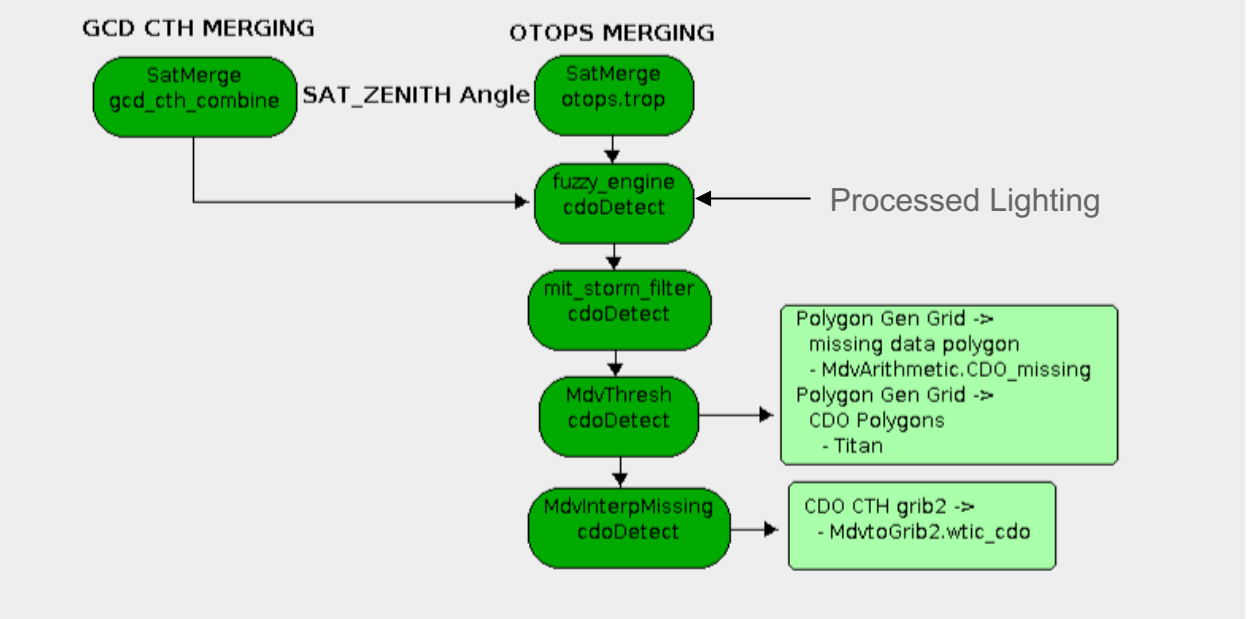
Smart Merging of satellites
- Satellite zenith angles used in overlap coverages areas.

Fuzzy logic used to combine GCD, CTH, lightning, and overshooting tops.

Some smoothing and thresholding applied before producing the polygons.

Use interpolation of surrounding points to fill in missing data points.

CDO processing (6 processing steps)



https://projects.ral.ucar.edu/ocnd/sysview/ocn4/CDO-CTH.html

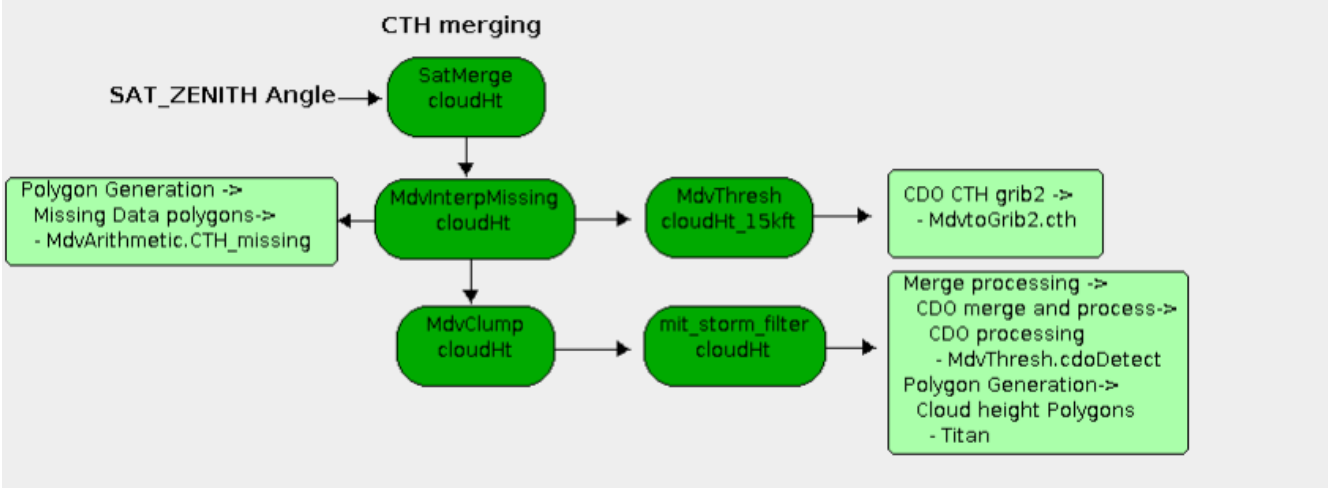
Processing Steps

Merging CTH from individual satellites.

Gridded output contains cloud top height that are at 15kft or greater.

Some smoothing and thresholding applied before producing the polygons.

CTH processing (5 processing steps)



https://projects.ral.ucar.edu/ocnd/sysview/ocn4/CDO-CTH.html

Robustness of the system

Robust system design

- Underlying infrastructure has been used for over 25 years
- Linux OS
  - Time based job schedular (CRON)
    - Keeps the auto_restart process running
- Hardware and missing input data are the main points of failure

Key components of the system

- Procmap
  - A C++ base application that monitors the processes.
  - Each process registers and sends heartbeat messages.
  - Procmap retains the following information for each process
    - Name, Instance, Host, User, PID, HeartBeat, UpTime, Number of registrations, and a status message
- Auto restart
  - A perl based script that starts system applications.
  - Uses the procmap information to determine if a process is frozen or not running
- Janitor
  - Data scrubber
- DataMapper
  - Retains information about the data

Thank You!
Questions?