Prototyping Dish LMC: Pointing activity

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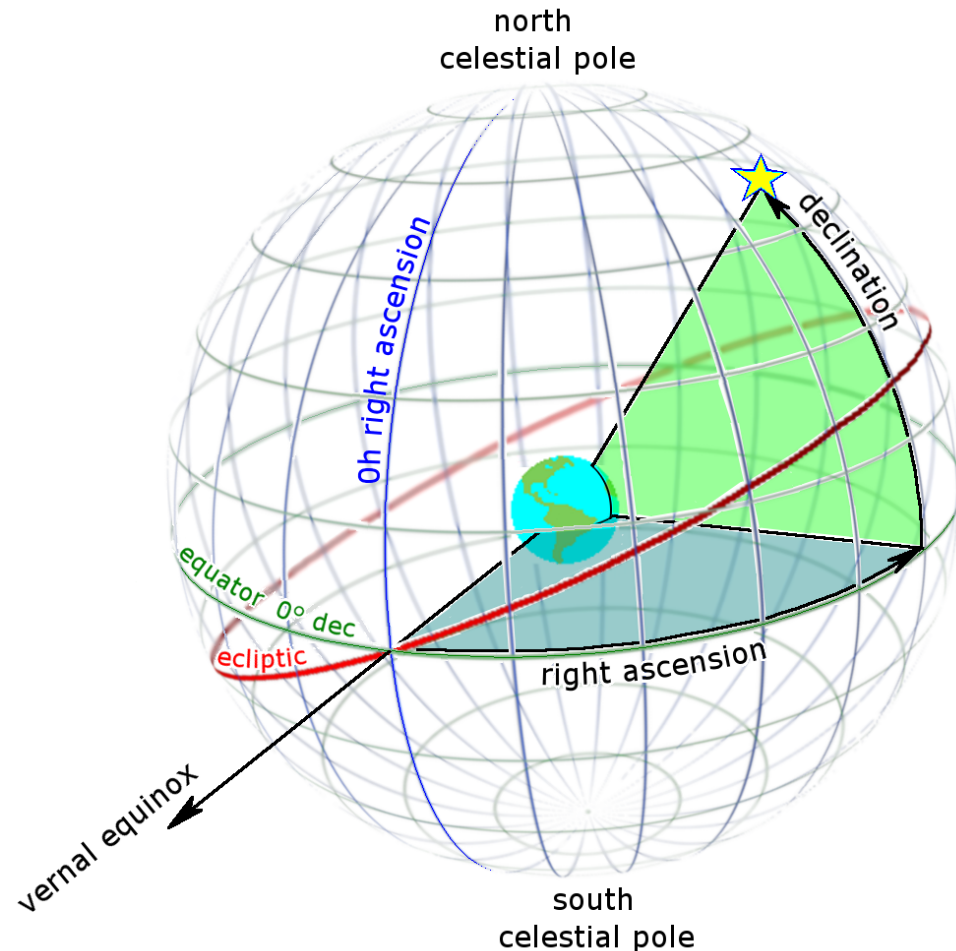
Equatorial system

A source is characterized by:

- **right ascension (RA)**

- **declination (DEC)**

The equatorial system is (almost) unbounded to the Earth motion (rot+rev+prec):

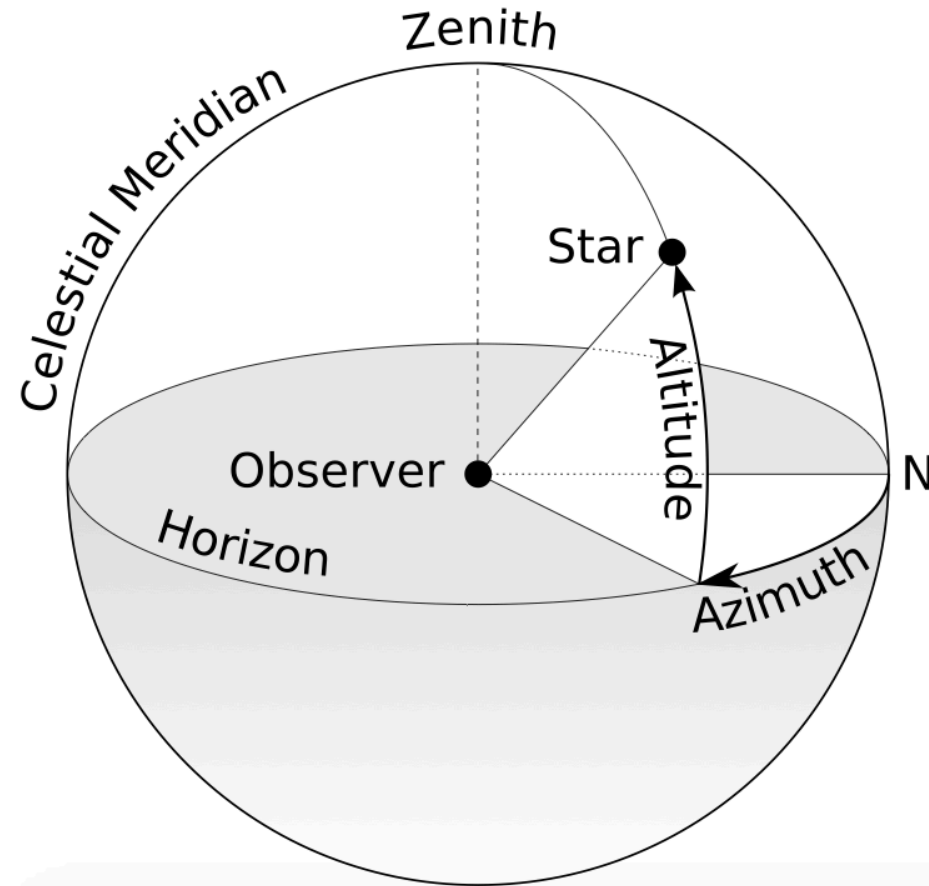**source RA and DEC do not change in time***

* this is not true!

Credits: wikipedia.org

Horizontal system

A source is characterized by:

- **elevation or altitude (El)**
- **azimuth (Az)**

Az and El are:

- **local (dep. on lat,lon)**
- **time dependent (Earth rot.)**
- **epoch dependent (Eq. prec.)**
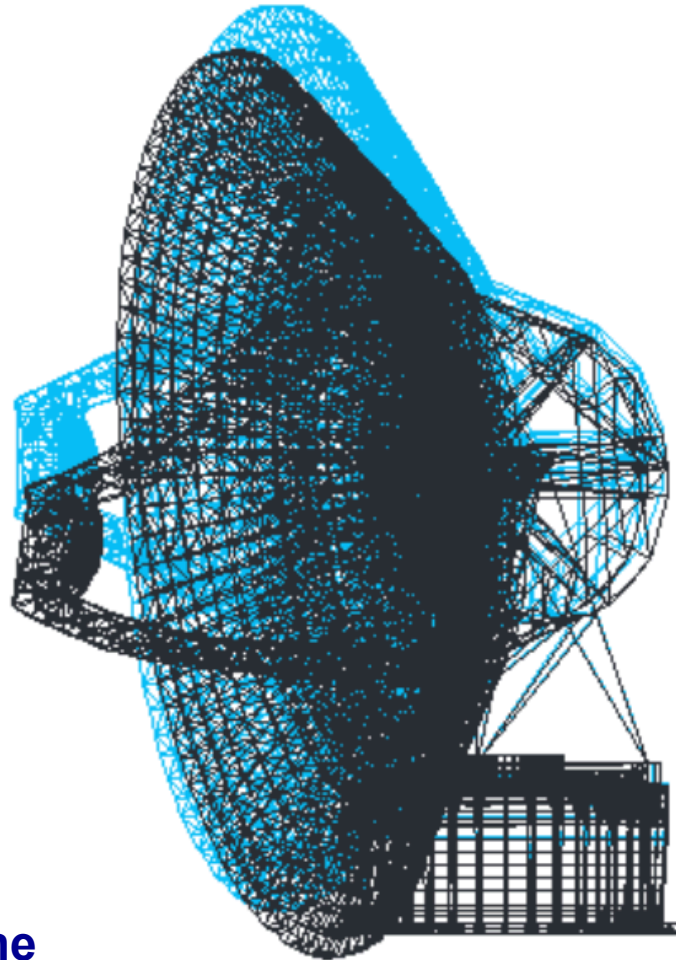- **and more…**

Credits: wikipedia.org

… they need to be corrected for "engineering" problems:

- **static corrections:**
  - *collimation errors*
  - *encoder (fixed) offset*
  - *axis skew*
  - *azimuth axis tilt*
  - *structural flexure due to gravity*
- **dynamic corrections:**
  - *thermal deformation*
  - *wind*
  - *atmospheric refraction*

Example of gravity-induced deformation

70-m antenna at Goldstone

Requirements

R.LMC.CC.SFW.ITM.1 **LMC Receive pointing control**	LMC shall receive time stamped, or in polynomial form, Az/El pointing control commands from TM.
R.LMC.FMD.SFW.ISE.1 **Sensor values reading by DS**	LMC shall read all actual sensor values provided by DS with a time stamp resolution of 100ms (TBC), and an absolute time accuracy of 1ms (TBC).
R.LMC.CC.SFW.PNT.1 **Configure static Dish Model Parameters**	LMC shall use the static Dish Model Parameters provided by TM and store them in a file as default parameters. This model shall include structural deformations due to gravity.
R.LMC.CC.SFW.PNT.2 **Configure dynamic Dish Model Parameters (if applicable)**	LMC shall use a model provided by TM to compute pointing corrections based on sensors (tilt, Temp). (Formula to derive δAz, δEl)

Requirements

R.LMC.CC.SFW.PNT.3 **LMC interpolate pointing**	LMC shall interpolate the Az/El time stamped (or polynomials) received by TM with a resolution on 0.1 s
R.LMC.CC.SFW.PNT.4 **LMC compute static pointing corrections**	LMC shall compute static pointing corrections based on static model parameters provided by TM and the interpolated values Az/El: $\Delta Az=f(Az, El, \text{static-param})$ $\Delta El=f(Az, El, \text{static-param})$
R.LMC.CC.SFW.PNT.5 **LMC compute dynamic pointing corrections (if applicable)**	LMC shall compute dynamic pointing corrections based on the dynamical model provided by TM, the interpolated values Az/El and the tilt sensors: $\delta Az=f(Az, El, \text{sensors})$ $\delta El=f(Az, El, \text{sensors})$

Requirements

R.LMC.CC.SFW.PNT.6 **LMC compute corrected time** **stamped Az El**	LMC shall compute corrected time stamped Az/El: $Az'=Az+\Delta Az+\delta Az$ $El'=El+\Delta El+\delta El$
R.LMC.CC.SFW.PNT.7 **LMC send pointing control to DS**	LMC shall send the time stamped corrected pointing commands to DS through the ISE service.
R.LMC.FMD.SFW.ITM.2 **AZ/EL list continuous** **transmission to TM**	LMC, while DS is in the operating states, shall send to TM with a time resolution of 100ms (TBC) and a timing accuracy of 1ms (TBC), time stamped estimated Az/EL values.

Requirements

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R.LMC.FMD.SFW.ARC.1 **AZ/EL list continuous archive**	LMC, while DS is in the operating states, shall archive time stamped estimated Az/El pointing positions (compensated for local corrections) with a time resolution of 100ms (TBC) and a timing accuracy of 1ms (TBC).
R.LMC.FMD.SFW.MON.1 **Sensor values aggregation**	LMC shall package all gravity, tilt and other sensors values that are used to apply local pointing corrections, in a data packet with a time stamp resolution of 100ms (TBC), and an absolute time accuracy of 1ms (TBC).

Requirements

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R.LMC.FMD.SFW.ITM.3 **Sensor values transmission to TM**	LMC shall report data packets about all gravity, tilt and other sensors values that are used to apply local pointing corrections to TM, with time stamp resolution of 100ms (TBC), and an absolute time accuracy of 1ms (TBC).
R.LMC.FMD.SFW.ARC.2 **Sensor values archiving**	LMC shall archive data packets about all gravity, tilt and other sensors values that are used to apply local pointing corrections with a time stamp resolution of 100ms (TBC), and an absolute time accuracy of 1ms (TBC).

LMC blocks involved
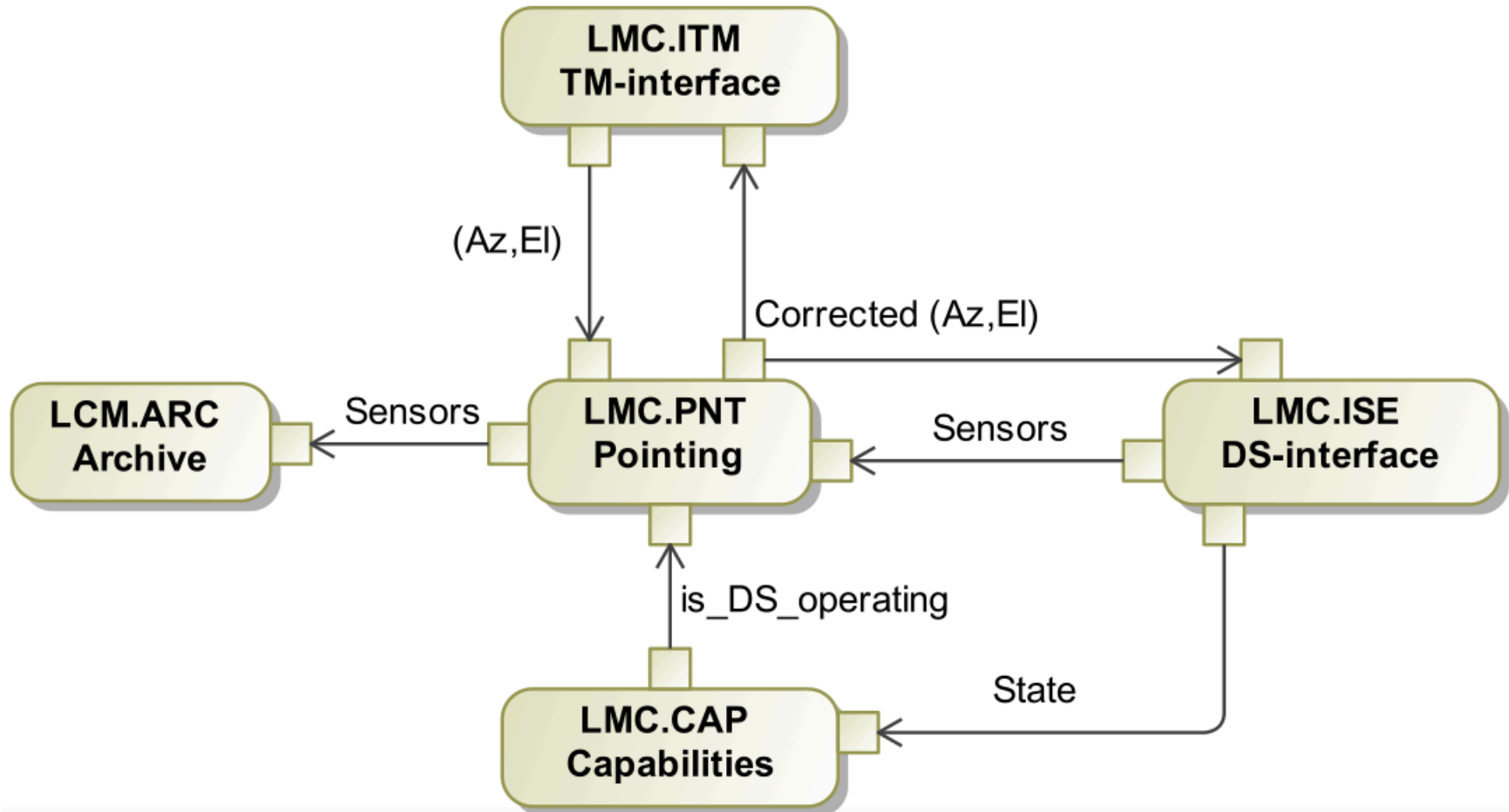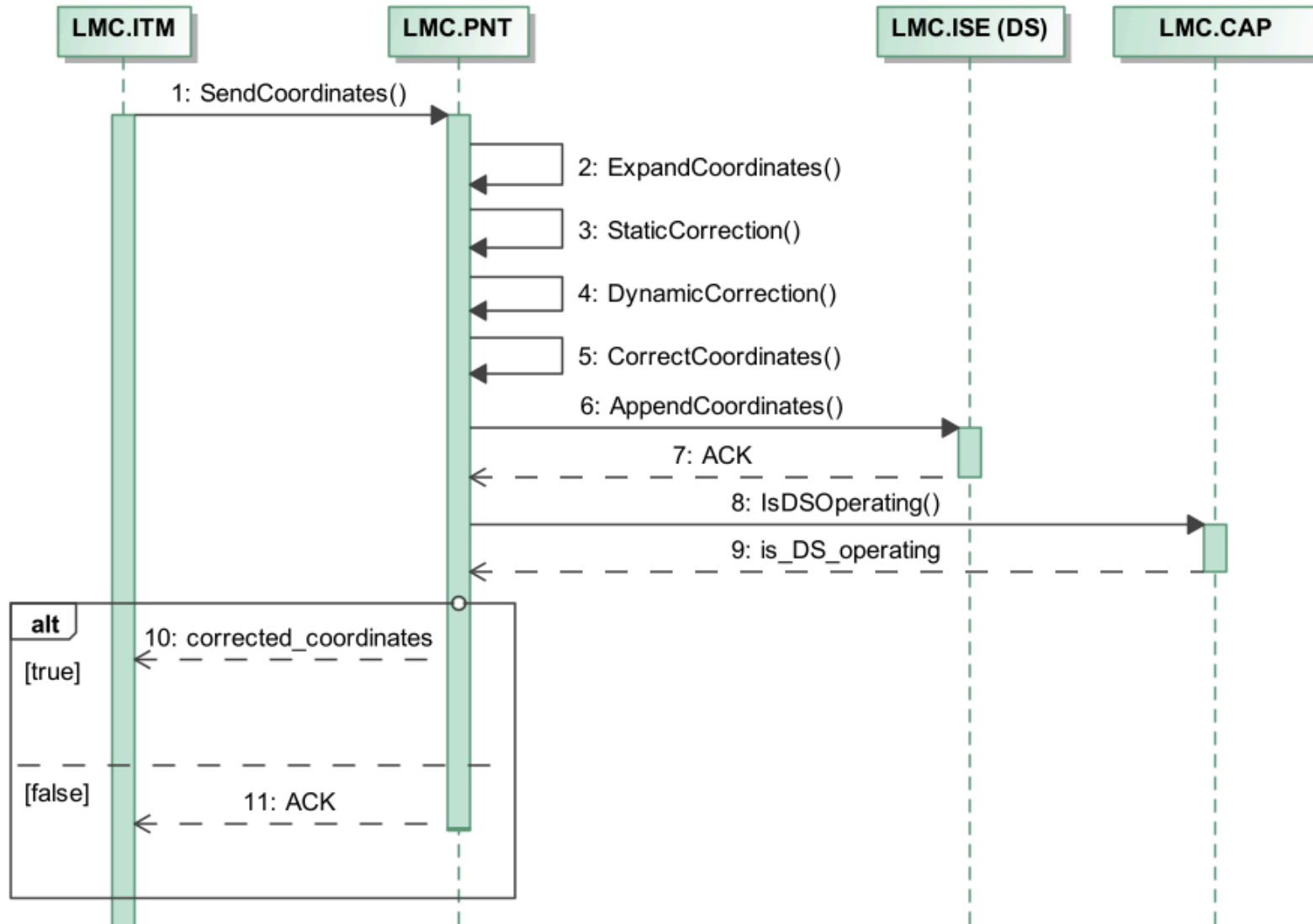
Pointing class diagram
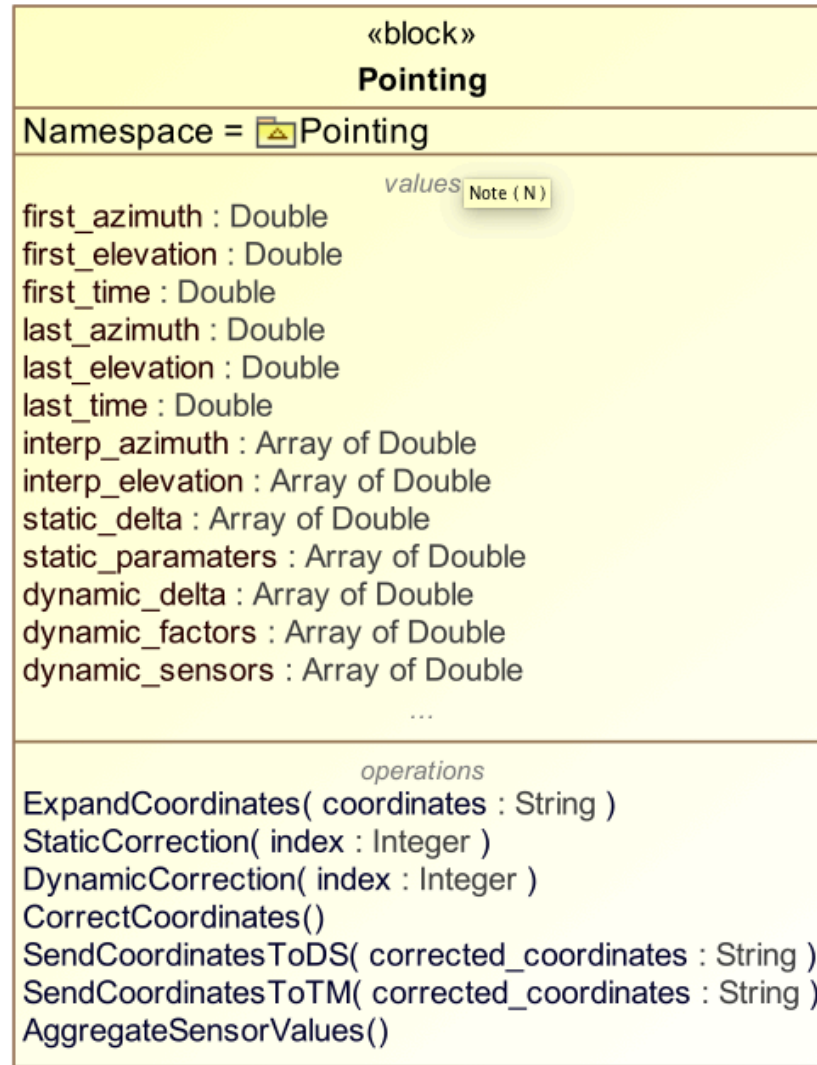
Pointing activity diagram
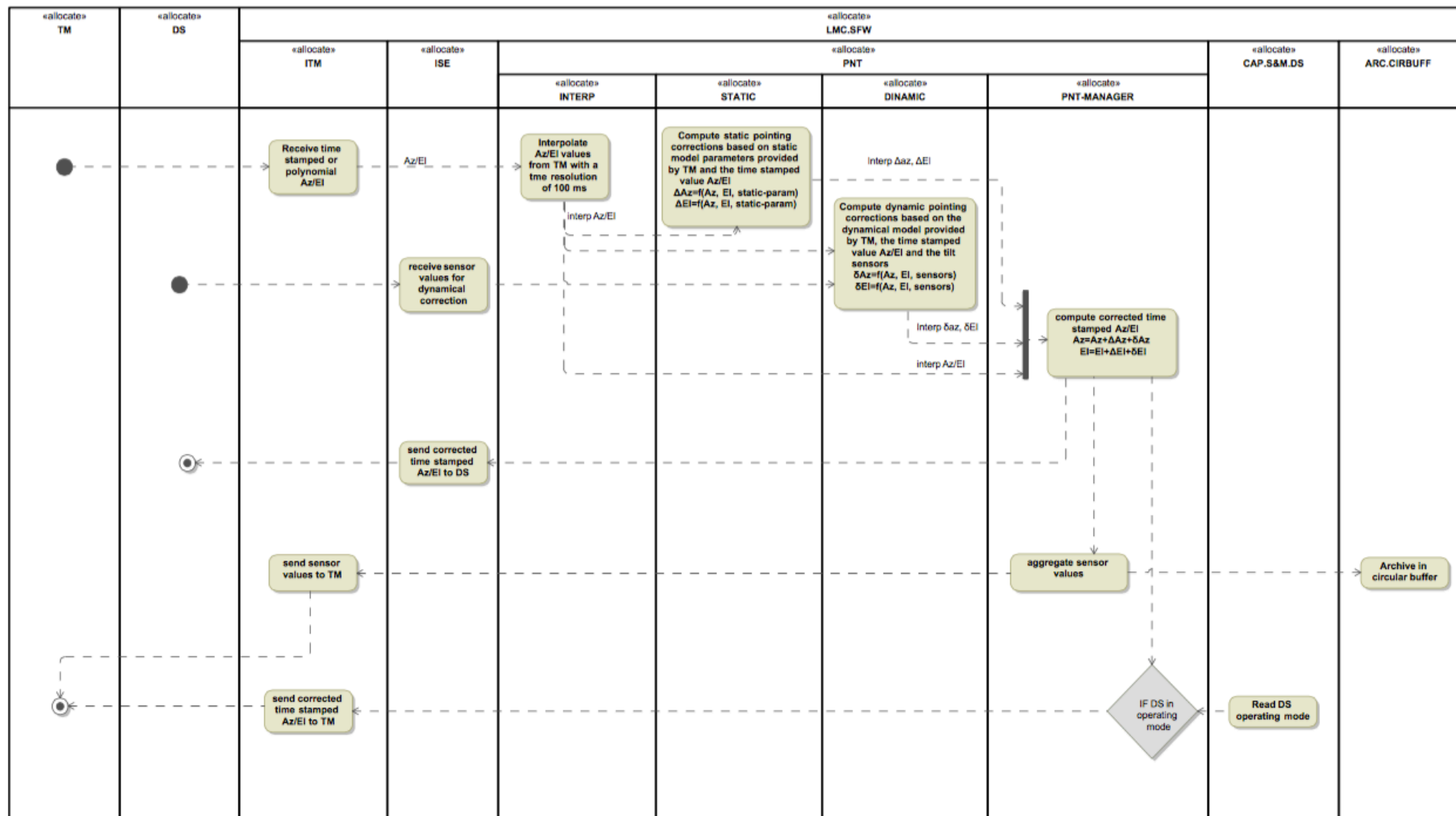
Sequence diagram

Assumption:

- TM sends time-stamped (Az,El) once per second

- DS exposes a command to receive corrected coordinates

- static correction formula is derived from Noto antenna

- dynamic correction is a simple algebraic operation

Thank you!