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Title: "MeqTree: prototype calibration package for LOFAR"

Author: J.E.Noordam

Institute: ASTRON, Dwingeloo, The Netherlands

1 The MeqTree module

- Urgently needed: A package that can implement an arbitrary Measurement Equation (M.E.), and solve for arbitrary subsets of its parameters. The MeqTree module is one way to achieve this.
- The MeqTree kernel contains 'forests' of trees (graphs, really) that consist of nodes. The latter calculate values for the cells of a domain, which is usually a rectangle in freq-time space. Whenever a node receives a request, it passes it to its children and waits for the results. It then combines these into a result of its own. Most nodes perform mathematical operations, but there are special nodes for generic operations like solving, flagging etc. Leaf nodes have no children, but use other information to satisfy requests. Examples are spigot nodes that access data, or parm nodes that represent M.E. parameters. A forest may have many thousands of nodes.
- The MeqTree kernel must be interfaced with other modules to form a reduction package. At this moment, it interfaces with AIPS++, which offers sufficient functionality.

2 Application to radio aperture synthesis

- The MeqTree module can implement the highly complex Measurement Equations that are required by the new generation of giant radio telescopes. It can also implement better M.E.'s for the existing telescopes.
- Boundary condition: It will be a great challenge to handle the very large data volume from LOFAR and other new radio telescopes (SKA, ALMA). Some new ideas are needed to achieve this.

1. Peeling: Reduces processing by a large factor (3-4 orders of magnitude) by tackling the sources/patches one-by-one, after shifting the phase centre to their position. The latter allows prediction at a very much lower (f,t) resolution. NB: Forms of peeling have been attempted

by experienced radio astronomers in the existing packages. It clearly works very well, but is very painful since these packages have not been designed for it.

2. Subtracting the many sources of the Local Sky Model (LSM) without knowing their individual details. Since this operation will probably be the real bottleneck (rather than selfcal), any gains in efficiency here will be important. NB: This involves interpolation of 'uv-bricks'. It turns out that similar tricks can be used to do selfcal without an LSM (exploiting 'weak' redundancy), eliminating contamination by other sources when peeling, transient detection, EoR detection, etc.

3. Other ideas....?

- Ionospheric model. If there is not enough S/N to solve for individual telescope phases, there may be enough to solve for a single phase gradient over the array. A 'minimum' ionospheric model does not concern itself with the internal structure of the ionosphere, but only describes its effect on the observations with the minimum nr of parameters. These will include the station positions and the viewing direction, and perhaps the TID velocity and direction.