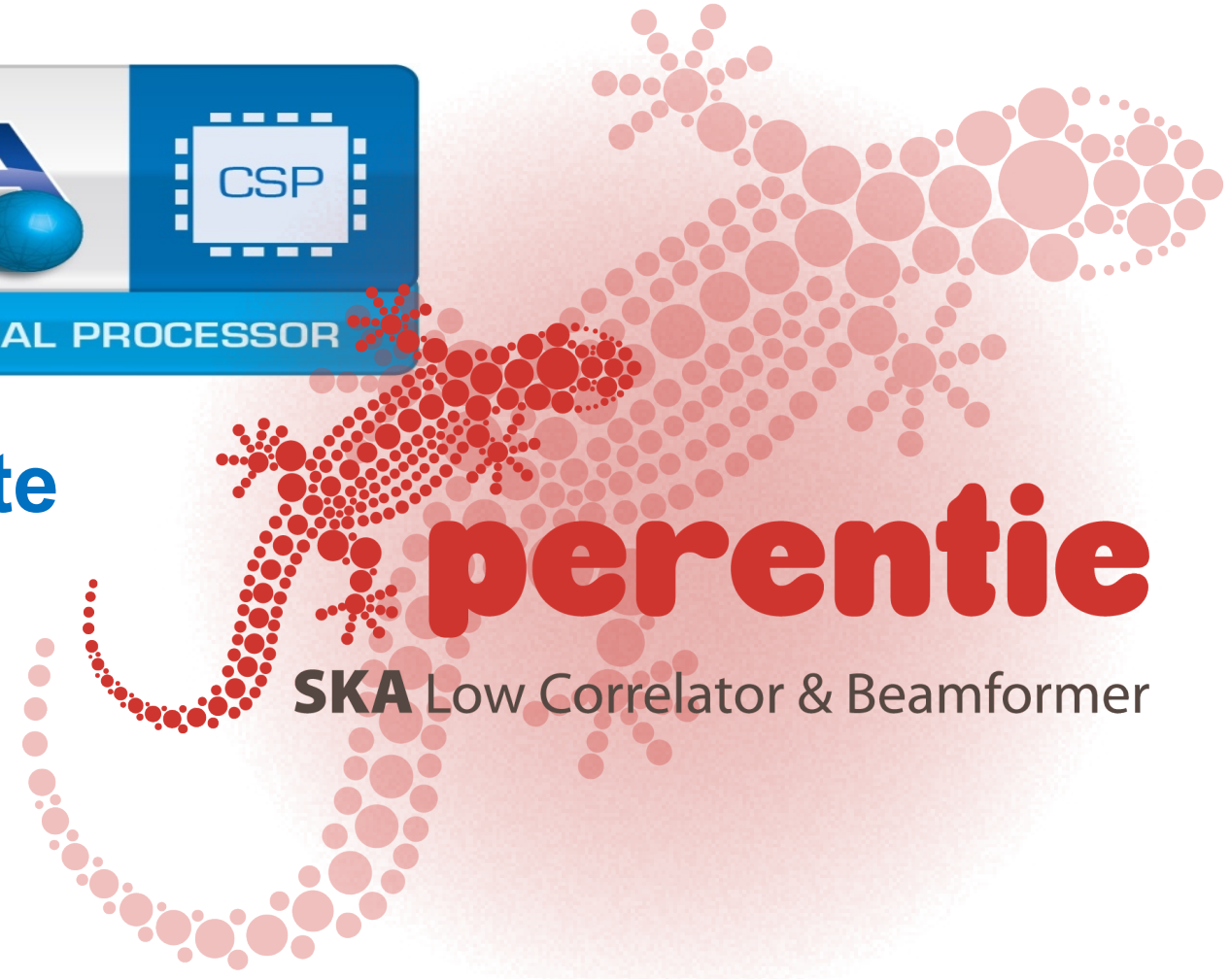




# Perentie CSP LOW CBF Update

Dr. Grant Hampson

13<sup>th</sup> November 2015  
SKA Engineering Meeting



# ASTRON



# SKA Engineering Meeting 2015

Thankyou David Loop  
for a great CSP presentation!

- It was a tough crowd  
with tough questions





# LOW CBF Collaboration Formed

ASTRON,  
Curtin  
CSIRO      Strong and  
NZA      united team!





# Current LOW CBF Team

## CSIRO

- Grant Hampson
- John Bunton
- Andrew Brown
- John Tuthill
- Tim Bateman
- Daniel George
- Yuqing Chen

## ASTRON

- Andre Gunst
- Hajee Pepping
- Eric Kooistra
- Agnes Mika
- Koos Kegel
- Gijs Schoonderbeek

## NZ

- Peter Baillie
- David Wilson

## Curtin

- Steve Ord



# Resource Gaps

## LOW CBF M&C Software

- **Tango/GUI layers**
  - ? – TM, NRC Collaboration, CSIRO, ASTRON

## CSP LOW Scientist

- **Steve Ord departing**
  - Some possible options being investigated

## CSP LOW System Engineer

- **Steve Ord departing**
  - Very difficult (CSP wide resource)



# Software Correlator

**Curtin's involvement in LFAA and MWA means they are ideally positioned to develop a small SW correlator**

- **Existing in-house capability/instrument**
- **Sufficient for up to 4 stations, doesn't require SDP, TM, etc.**



**Array Release 1 (AR1) will contain 8 stations**

- **Complete end-to-end LOW system using a FPGA correlator**

# LOW CBF Approach

**The collaboration is approaching the design in a genuine, open-minded and consultative manner**

- **Everyone gets the opportunity to be heard**

**Three significant meetings:**

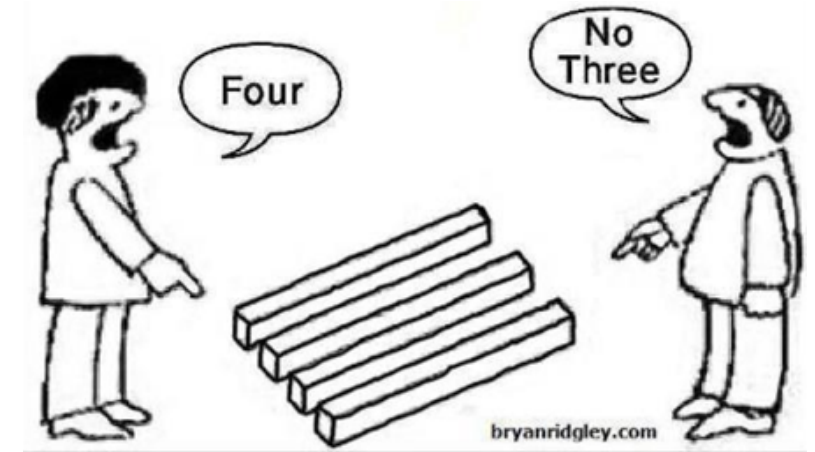
- **Jul'15: Edinburgh – Planning**
  - Collaboration meets for the first time, understanding approaches
- **Sep'15: San Francisco – Kickoff / Icebreaker**
  - Engineers meet and options tabled
- **Nov'15: Sydney – Downselect / Delta-PDR**
  - All major design decisions made – foundations set
  - Commenced writing documentation for Delta-PDR submission for end-Jan'16





# Downselects

All key downselects have come to an agreeable conclusion ready for Delta-PDR:



## ✓ Time Reference

- ✓ Precision Time Protocol (PTP) distributed via Ethernet switch using existing M&C path.

## ✓ Delay Method

- ✓ Phase shifts on narrow frequency channels shown to be optimal for LOW

## ✓ Correlation Cell

- ✓ Hybrid ASTRON/CSIRO cell design with special input distribution circuit



# Hardware Downselects

## ✓ FPGA Vendor

- ✓ Xilinx Virtex Ultrascale+ in pre-construction period.

## ✓ #FPGAs per board

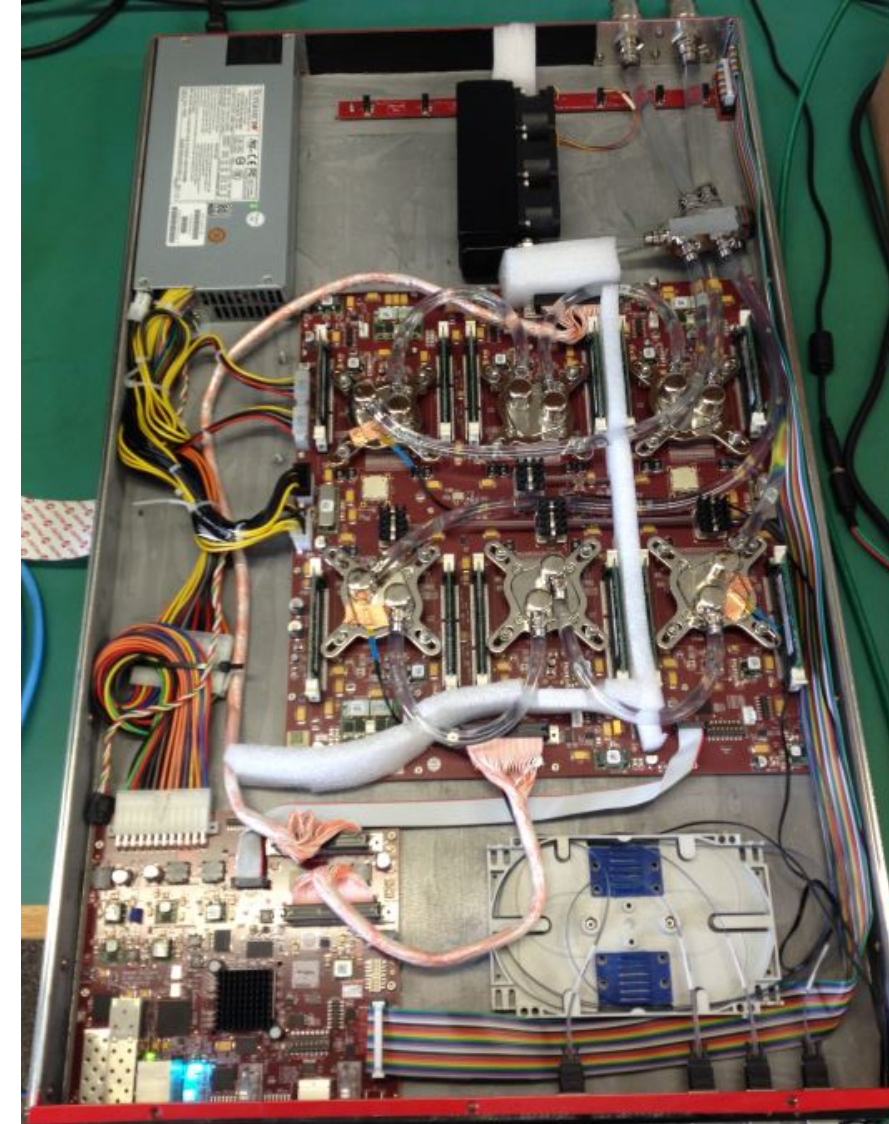
- ✓ one FPGA,  
unless firmware partitioning shows otherwise

## ✓ Cooling

- ✓ Primarily liquid for high power components  
as well as internal air circuit.

## ✓ Packaging

- ✓ Pizza box as long as suitable IO and  
optical circuits/cabling solutions are in place

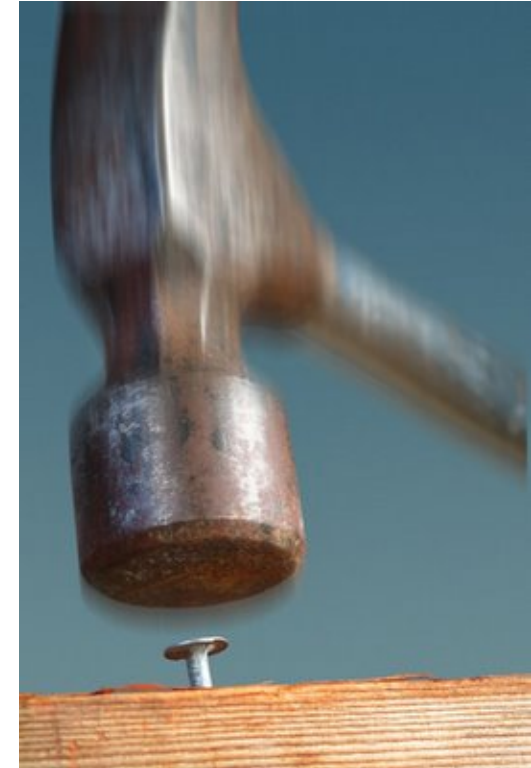


# Hardest Downselect

- ✓ Partitioning of FW onto HW – Filterbanks combined and separate COR/BF, later further optimisations may be possible.

Most complex downselect to resolve, effecting

- Firmware development
- Power consumption
- Testing time
- Number of cabinets
- Possible redundancy

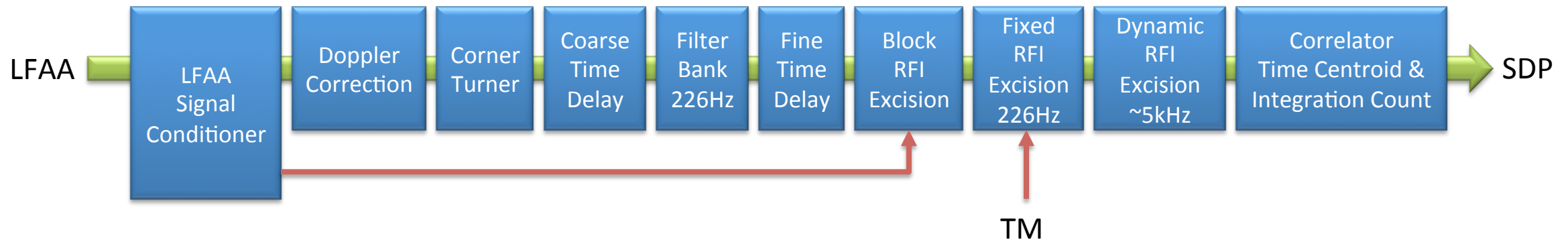


Full optical interconnect allows change without major consequences



# Algorithm Downselects

- ✓ **Signal Processing Model – RFI excision, Time Delays, Correlator Channel accumulation agreed.**



**With all these downselects we can commence the Delta PDR since we have agreed on this**

**Where to next?**





# LOW CBF Meetings and Workshops



- **Penticton 9-13<sup>th</sup> November 2015**
  - **SKA Engineering Meeting + CSP meeting (now!)**
- **DSP Modelling Webex**
  - **Weekly with David Wilson to progress golden signal processing model**
- **Christmas 2015 – Delta-PDR draft complete**
- **Mid-Dec / Jan – SKAO Delta-PDR Progress Reviews**
- **End January 2016 – Delta-PDR submission**

# LOW CBF Meetings and Workshops

- **15-19 Feb: Prototyping Workshop**
  - Delta-PDR review day at ASTRON with SKAO present ?
  - Ver A - Board discussion - Components, software training, downselects
  - Progress on Firmware Demos & Framework
- **April 2016 CSP wide TIM#5 team meeting**
  - Madrid? Sydney?
  - DSP Model demonstration
- **Pre-CDR Review Sep 2016**
- **SKA Engineering Meeting (Stellenbosch): 2<sup>nd</sup> – 6<sup>th</sup> October, 2016**
- **Sub-element Pre-CDR Dec 2016**
- **SKAO: CDR Review March 2017**



# Delta PDR Deliverables for Low.CBF

See CIDL collection 130 on docushare (and CSP SOW)

1. Contributions to:

|       |   |            |      |
|-------|---|------------|------|
| SE-6a | Interface Control Document CSP to INFRA (SE-6a) | N. Loubser | 100% |
|-------|---|------------|------|

2. Contributions to:

|       |   |                |     |
|-------|---|----------------|-----|
| SE-7b | Interface Control Document LMC to CSP Sub-elements (SE-7b)                  | S. Vrcic       | 50% |
| SE-7e | Interface Control Document Low Correlator and Beamformer to Low PST (SE-7e) | W. van Straten | 50% |
| SE-7f | Interface Control Document Low Correlator and Beamformer to Low PSS (SE-7f) | B. Stappers    | 50% |

3.

|      |  |        |     |
|------|--|--------|-----|
| EA-1 | SKA CSP SKA1-Low Array Correlator Sub-element Requirement Specification (EA-1) | S. Ord | 50% |
|------|--|--------|-----|

4.

|       |  |            |     |
|-------|--|------------|-----|
| EA-4a | SKA CSP SKA1-Low Array Correlator Sub-element Detailed Design Document (EA-4a) | G. Hampson | 50% |
|-------|--|------------|-----|

5.

|           |                            |            |     |
|-----------|----------------------------|------------|-----|
| Proto-LOW | Prototype Plan for LOW CBF | G. Hampson | 50% |
|-----------|----------------------------|------------|-----|

6. Risk Register (see collection 717)

7. Compliance statement (could be via EA-4a appendix)

8. ILS/RAMs spreadsheet (collection 1823, drs email Aug 14)

9. Pre-construction “Plan” – tailoring of CSP PMP/SEMP

10. Costing Spreadsheet (rolled up into PM-7)

11. Contributions to EICDs: LFAA, SDP, SaDT



# EICD Progress (1)

## LOW.CBF-SDP

- Major sticking point – use of SPEAD across multiple FPGAs is a major availability risk
  - SDP now appreciate problem
  - Solution for LOW – single frequency channel per HEAP
- Every thing else in reasonable shape

## LOW.CBF-SADT timing

- First discussion on this for LOW.CBF
- Agreed SADT provide necessary input for Precision Time Protocol (PTP), CSP will use PTP enabled switches

## LOW.CBF-SADT-SDP

- Richard Hughes-Jones has discussion document. Reviewed and agreed
- Note SADT supply QSFP28, but not installed as front panel pluggable
- Packet address from SDP via TM



## **EICD Progress (2)**

### **CBF.LOW-INAU**

- All items from previous telecon now in ICD. These were checked off and agreed.
- TBC on rack load, currently 500kg, need to increase

### **LFAA-SADT-LOW.CBF**

- This will disappear, distant station via LFAA data network. Simpler ICD structure

### **LFAA-LOW.CBF**

- Responsibility passing to ASTRON for completion
- Agreed items from previous telecom not updated in ICD
- Major sticking point LFAA have 2 stations on 40G link – 256 MPO connections
  - We want fewer fibres saves 10% hardware, 2% power
  - Prefer 4-6 stations on 100G link, or 3 stations (34Gb/s) on 40G link
  - LFAA to look at possibility of 3 stations on 40G link

# PDR Content

## Instructions from Dave, Phillip, Marco

- **To meet time and resource constraints, we have to address the logical/functional aspect rather than the physical implementation.**
- **I am not saying do not work on the technological aspect, of course it is important because there are several risk associated with it, but as 'preliminary' design I believe it is more important to proof the design compliancy even if the design is only functional/ logical. Hence the DDD has got the compliancy matrix section and it should be fully documented to support the system PDR.**

# Project Data and Tracking

## Docushare

- All documentation - thankyou NRC

## Google docs

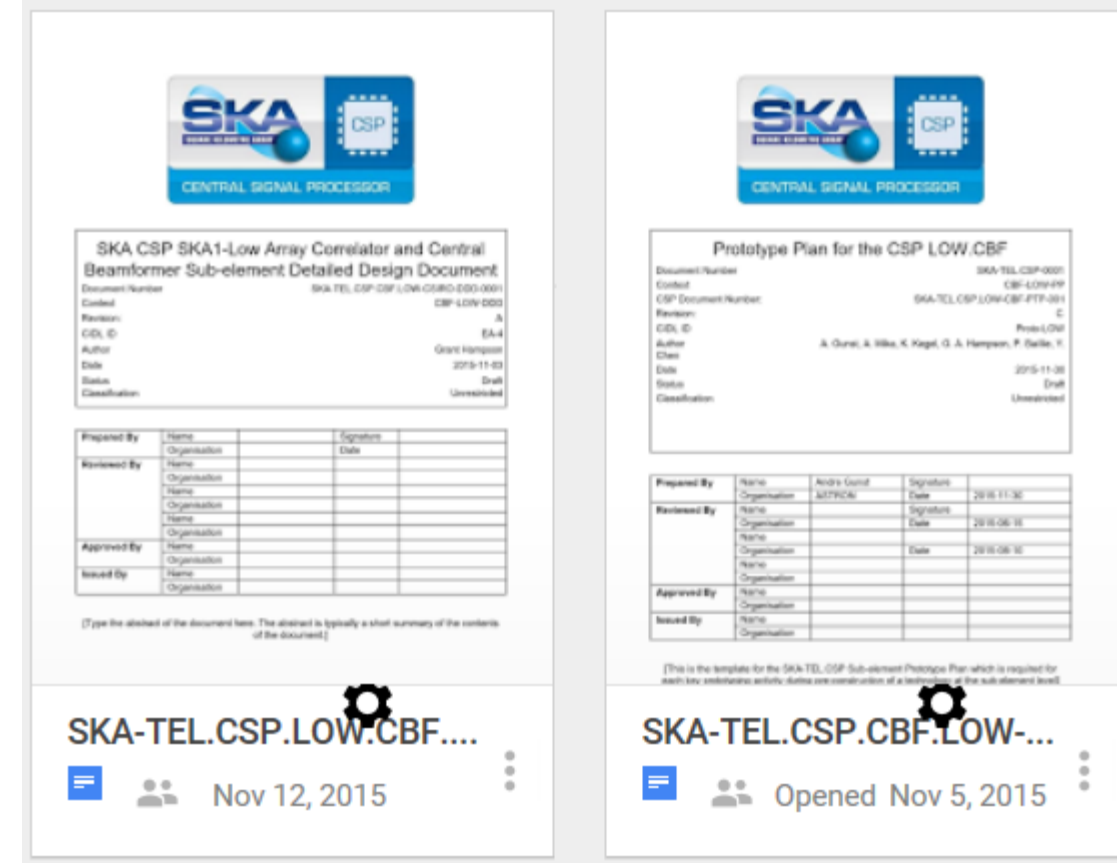
- Prototype plan and DDD

## Redmine

- Issue and task tracking
- Divided by work package

## Subversion

- Coming soon – will be connected to Redmine
- All FW, SW and HW source files



**SKA CSP SKA1-Low Array Correlator and Central Beamformer Sub-element Detailed Design Document**

Document Number: SKA-TEL-CSP-LOW-CBF-001  
Code: CSP-LOW-001  
Revision: A  
CDS ID: SA-4  
Author: Grant Hampson  
Date: 2015-11-03  
Status: Draft  
Classification: Unrestricted

| Prepared By | Name | Organisation | Signature | Date |
|-------------|------|--------------|-----------|------|
| Reviewed By | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
| Approved By | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
| Issued By   | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |

(Type the abstract of the document here. The abstract is typically a short summary of the contents of the document.)

SKA-TEL.CSP.LOW.CBF....

Nov 12, 2015

**Prototype Plan for the CSP LOW.CBF**

Document Number: SKA-TEL-CSP-001  
Code: CBF-LOW-001  
CSP Document Number: SKA-TEL-CSP-LOW-CBF-PTT-001  
Revision: C  
CDS ID: Proto-LOW  
Author: A. Gurne, A. Sika, K. Nagel, G. A. Hampson, P. Sallis, Y.  
Date: 2015-11-03  
Status: Draft  
Classification: Unrestricted

| Prepared By | Name | Organisation | Signature | Date |
|-------------|------|--------------|-----------|------|
| Reviewed By | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
| Approved By | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
| Issued By   | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |
|             | Name | Organisation | Signature | Date |

(This is the template for the SKA-TEL-CSP Sub-element Prototype Plan which is required for each low sub-element activity during construction of a technology at the sub-element level.)

SKA-TEL.CSP.CBF.LOW-...

Opened Nov 5, 2015



# Publications

## National Radio Science Meeting (NRSM) URSI

- Boulder 6<sup>th</sup> - 9<sup>th</sup> January 2016
- “SKA LOW Correlator” – special session on SKA

## Conference suggested by SKAO

- SPIE – 26<sup>th</sup> June – 1<sup>st</sup> July, UK
- 30 May – paper 6 pages
- 15<sup>th</sup> Dec 2015 – submission 500 words

### COMMISSION J, Radio Astronomy

David DeBoer, (510) 520-9077, [ddeboer@berkeley.edu](mailto:ddeboer@berkeley.edu)

#### TOPICS

*Atacama Large Millimeter Array – Systems and Science*  
*Digital Developments*  
*Timing and Transients*  
*SKA Technical Development*  
*Emerging Instrumentation and Techniques*  
*New telescopes, techniques, and observations*  
*Timely technical tutorials*

# 2016 Prototyping Activities

## New hardware

- Version A of the FPGA board

## FW Demos

- Working demonstrations of PTP, 100GbE, Optics, HMC, partial reconfiguration

## FW Framework

- Common library, M&C system, register file, board support package

## Signal Processing

- Resource estimates, some development of high risk parts



## Version A Board

- April – June 2016, Andrew Brown @ ASTRON
- Gijs and Andrew – co-design and implementation
- Name is TBD

# Risks

**List of over 100 risks have been compiled from various sources**

- Many similar/duplicates

**Now have new systems engineer, categorising and rationalising the Risk Register – to be updated and reviewed**

## Major Risks

- Manpower Resource (especially SE and Software)
- Distributed Team
- Under staffed or indecisive SKAO
- Newness of Collaboration
- Short time frame to complete delta-PDR
- Power budget exceeded
- Cost budget exceed
- Requirement churn/incompleteness (transients?)
- Inaccurate match of resources required to hardware
- New components not meeting performance/delivery goals



# Perentie Monitoring and Control

Desire for standardisation

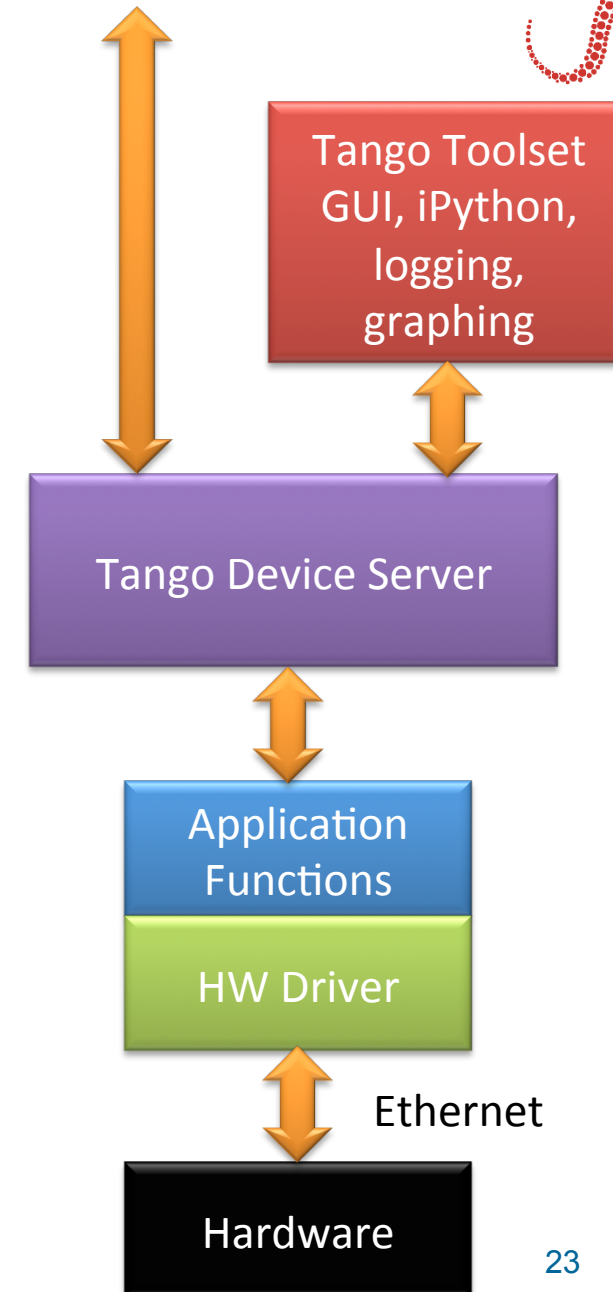
- HW communications (AXIoE?)
- Tango software environment

LMC/TM Interface enables the telescope manager to control the system and provide operator GUIs

- GUI's not a L3 requirement ?

Work in progress to determine responsibilities (TM, LMC and CBF)

CSP LMC



# Work Status Report

L3 Req't (highlight key assumptions)

- **Pretty good shape – Steve to complete before departure**

Status of DDD and compliance statement (do you meet all req'ts?)

- **Transferring PIP to DDD and sections allocated to team**

External interfaces for sub-element (all relevant EICDs and IICDs) – what's left to resolve?

What are the remaining dependencies?

- **Pretty good shape (see previous slides)**

Power estimates and refinement plan – when will we know what we need to?

- **Require more info from prototyping to reduce error bars**

Signal Models – golden model by TIM#5

- **Work in progress, tracking closely, but departure of Steve could slow progress**

Key Risk Register and TPMs walkthrough

- **Review in progress, however existing TPMs require more refinement due to some design changes**

Prototype Plan – traced to risks and TPMs

- **Existing plan being reworked and new TPMs being formulated**

Stage 2 Plan – including resources starting Mar 2015

- **Plan in progress and most resources secured against deliverables**



# Questions?

## Thankyou to the CSP and SKAO teams!

