On-Site ICT North concept – Networking

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CTAO,
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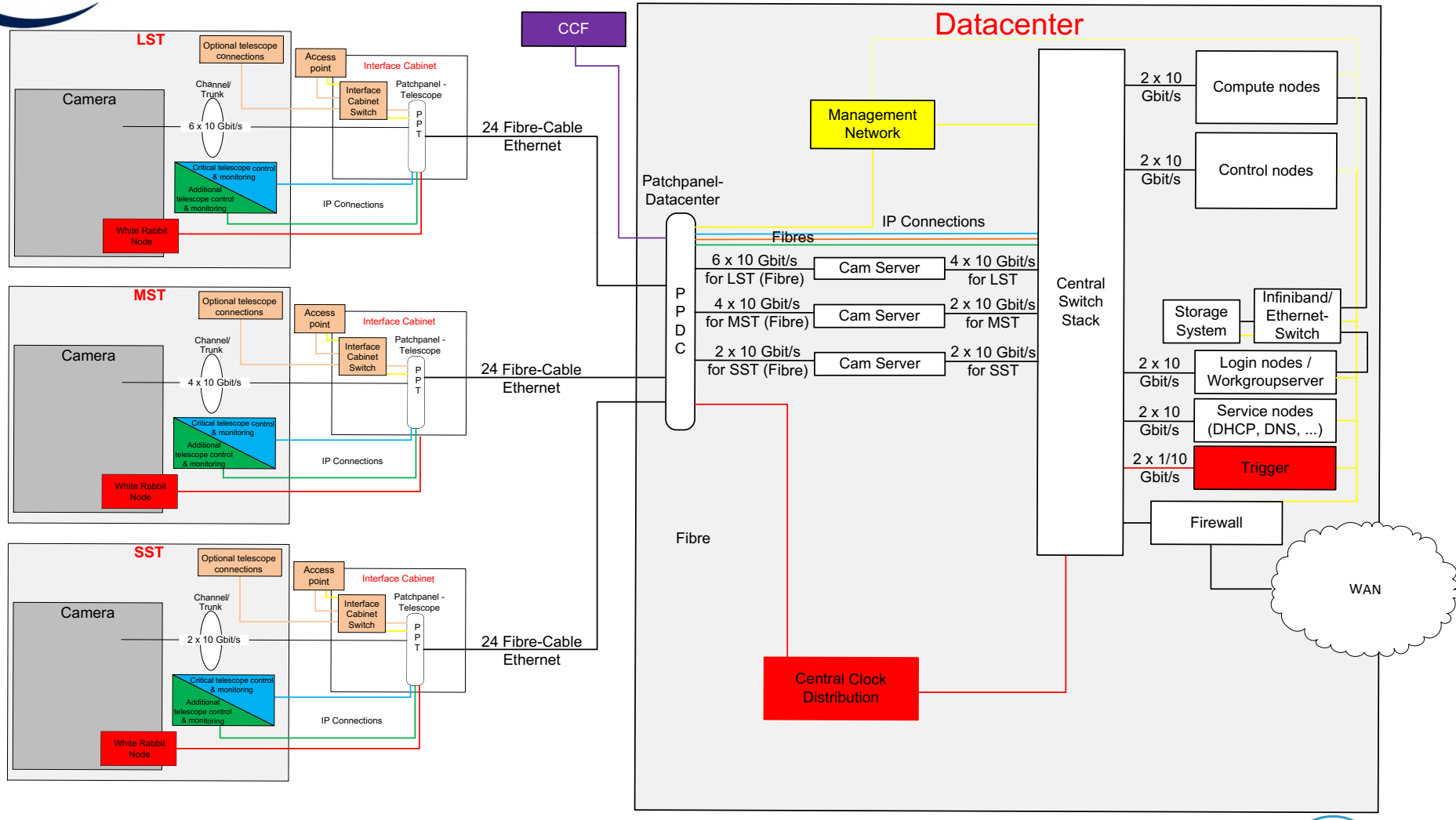
Concept & Design for CTA On-Site ICT Infrastructure - Scope



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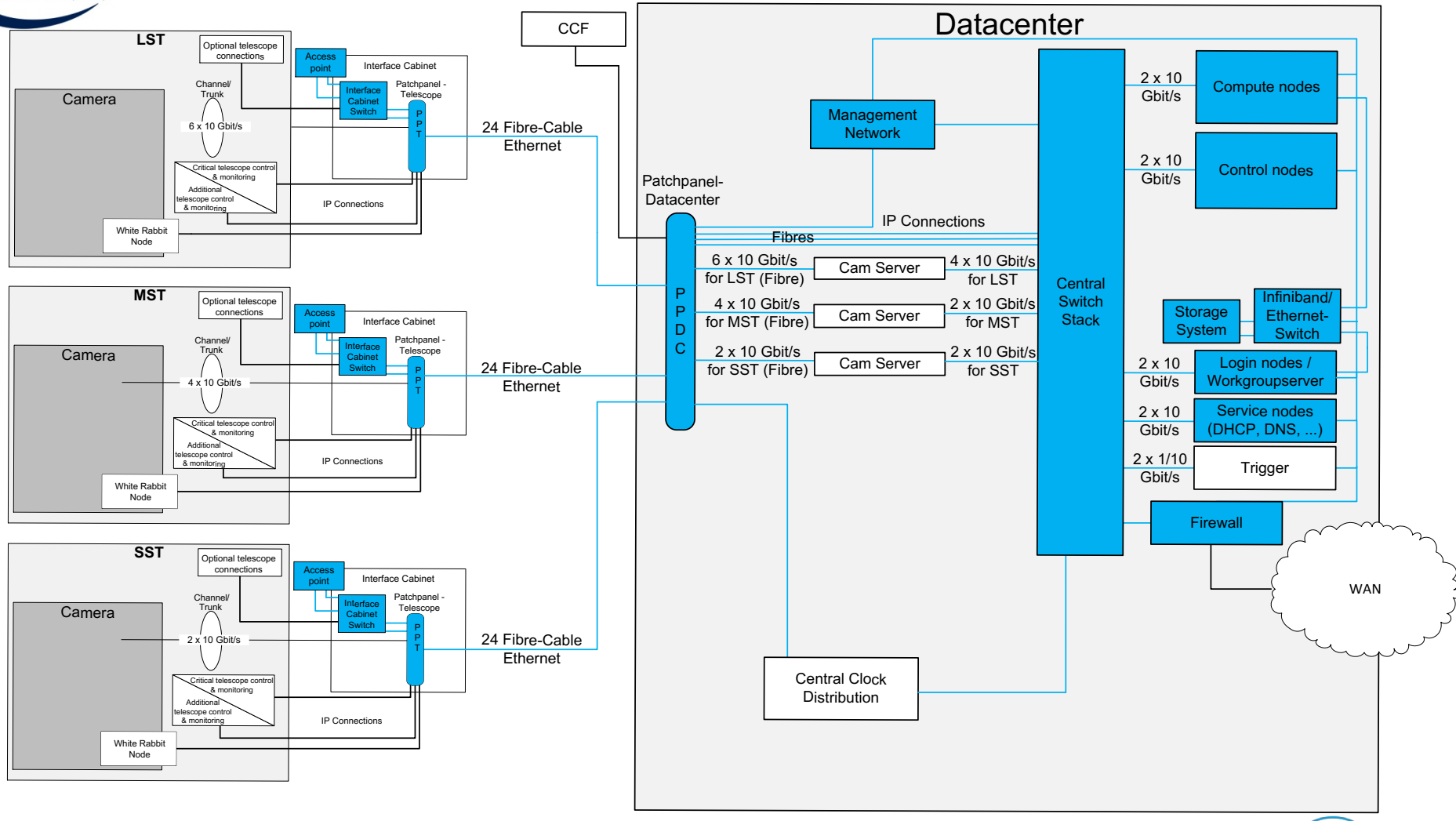
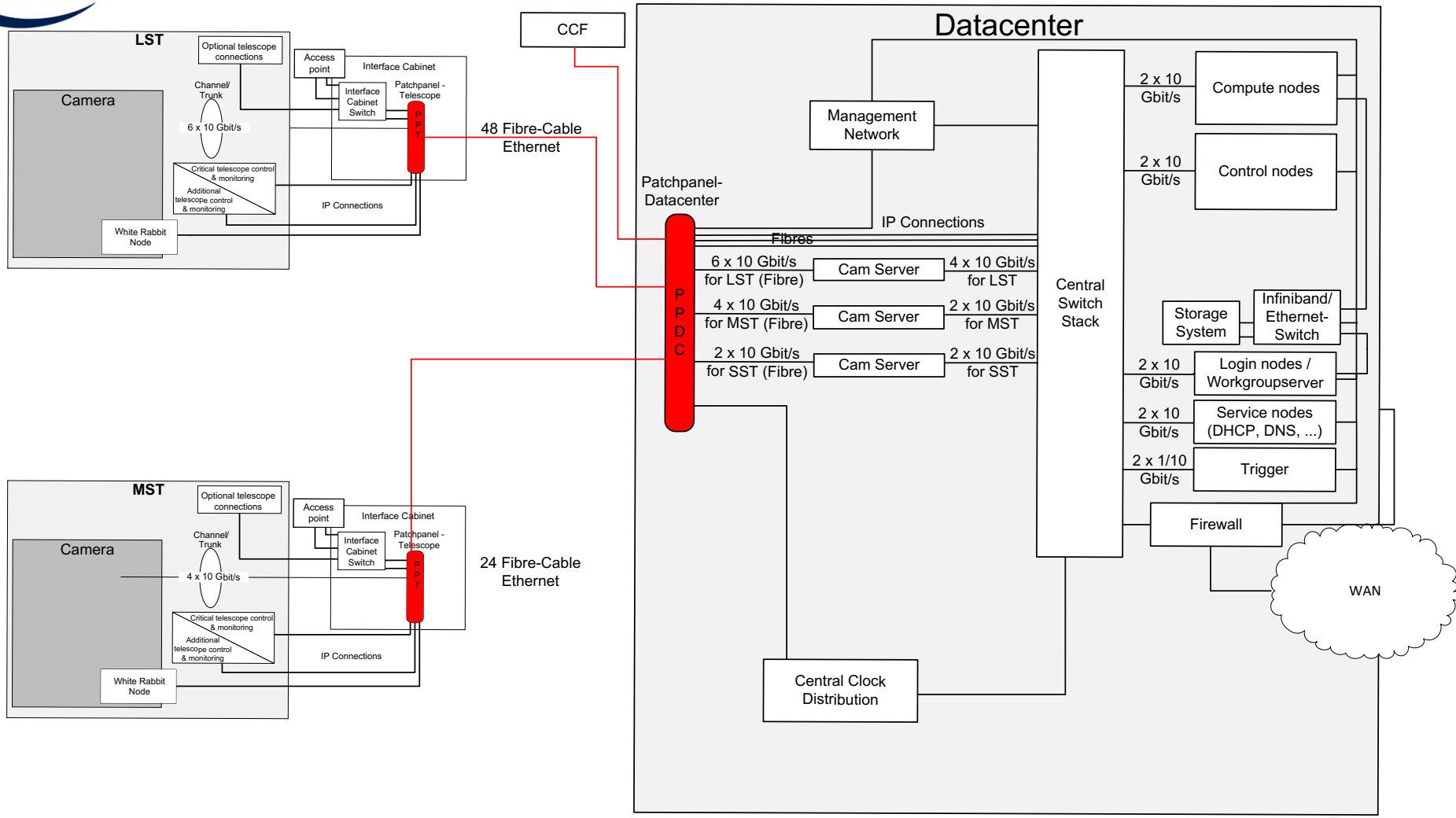


Concept & Design for CTA On-Site ICT Infrastructure - Network



Network: Connections Telescope – Data centre

Estimation of data rates – requirements

- The data rates between the telescopes and the camera servers (bulk data) and the Telescope and the data centre (control and monitoring interconnects) have been discussed in an interface meeting between the camera groups and ACTL in already 2015 and iterated until defined as requirements
- Derived from the given data rates the optical fibre connections have been defined

CTA-S MC Prod 2	Rate (Hz)	Hours/Y	All/prot	LST/ev	MST/ev	SST/ev	SCT	Samples
	22800	1314	1,4	0,7	2,22	0,54	1,11	0,03

Tel. type	NTel in E	NTel S	Ntel in 2N	Ntel N	Window (ns)	samples/ns	B/samp	HDR	Size/pixel	Pixels	Size int
LST	4	4	4	4	20	1,0	4	5	85	2.000,0	15
MST-NECT	12	12	15	8	60	1,0	4	5	245	1.855,0	15
MST-FL	12	12	0	7	60	0,25	2	5	35	1.800,0	15
SST-2M-G	24	24	0	0	100	1	2	5	205	2.048,0	15
SST-2M-AS	24	24	0	0	100	0,01	10	5	15	2.400,0	15
SSt-1M-DG	24	24	0	0	100	0,25	2	5	55	1.300,0	15
MST-SCT	12	0	0	0	50	1,00	2	5	105	11.000,0	15

Array E trig. rate 31920	Tel. type	NTel/Trig	Rate/Tel	Pix Samp	Gb/s	Evt S(kB)	Pix Int	Gb/s	Evt S(kB)	Gb/s Tot	Evt S(kB)
	LST	0,70	5.586	60	8,5E-01	166	1940	4,8E+00	28	5,7	194
	MST-NECT	1,11	2.953	56	3,6E+00	444	1799	7,1E+00	26	10,7	470
	MST-FL	1,11	2.953	54	5,0E-01	62	1746	6,9E+00	26	7,4	87
	SST-2M-G	0,18	239	61	5,4E-01	410	1987	1,3E+00	29	1,8	439
	SST-2M-AS	0,18	239	72	4,6E-02	35	2328	1,5E+00	34	1,5	69
	SSt-1M-DG	0,18	239	39	9,2E-02	70	1261	8,1E-01	18	0,9	88
	MST-SCT	1,11	2.953	330	0,0E+00	1128	10670	0,0E+00	156	0,0	1284
					5,6E+00			22,5		28,1	
Vol/Year (1314h)					3,2	PB		12,7	PB	15,8	PB

Vol South/year	15,8 PB	Bandwith (100% duty time)	4,76 Gb/s

CTA-N MC Prod 2	Rate (Hz)	Hours/Y	All/prot	LST/ev	MST/ev	Samples
	13000	1314	1,4	1,28	1,65	0,03

Array E trig. rate 18200	Tel. type	NTel/Trig	Rate/Tel	Pix act	Gb/s	Evt S(kB)	Pix Int	Gb/s	Evt S(kB)	GB/s Tot	Evt S(kB)
	LST	1,28	5.824	60	8,9E-01	166	1940	5,1E+00	28	5,9	194
	MST-NECT	0,88	2.002	56	1,6E+00	444	1799	4,8E+00	26	6,5	470
	MST-FL	0,77	2.002	54	2,0E-01	62	1746	4,7E+00	26	4,9	87
					2,7E+00			1,5E+01		1,7E+01	
Vol/Year (1314h)					1,5	PB		8,2	PB	9,7	PB

Vol North/year	9,7 PB	Bandwith (100% duty time)	2,93 Gb/s
Total Vol N+S/year	25,58 PB		

Telescope/Camera communication network – requirements

Project ID:
CTA_-PROD_INFRA-86
Global ID:
CTA-200900
Name:
B-INFRA-0710 Network Cable

Description:
Telescopes and other Controllable Systems must be provided with a cable network connection from the on-site Data Centre, which must be protected against damage for the entire cable length (between the System and the on-site Data Centre) without impeding access to the System.

Notes:
Adapted from B-INFRA-0210

Telescope/Camera communication network – requirements

CTA_-PROD_INFRA-87	CTA_-PROD_INFRA-88	CTA_-PROD_INFRA-90
B-INFRA-0720 Network Connection Description: Provision must be made for network connections to all Telescopes and Controllable Systems from the on-site Data Centre for control and monitoring purposes, plus data capture excluding Cherenkov Camera data, with a speed of at least 1 Gb/s and a latency of at most 0.1 seconds. Notes: New Requirement. Telescope Interface. Note that separate networks may be required for different functions	B-INFRA-0730 Network Data Link LST Description: Network links must be provided between each LST Camera and corresponding Camera Server within the on-site Data Centre, allowing data transfer with a speed of at least 48 Gb/s, facilitating the transfer of data at the required event rate. Notes: New Requirement. Telescope Interface	B-INFRA-0740 Network Data Link MST Description: Network links must be provided between each MST Camera and corresponding Camera Server within the on-site Data Centre, allowing data transfer with a speed of at least 32 Gb/s, facilitating the transfer of data at the required event rate. Notes: New Requirement. Telescope Interface

Telescope/Camera communication network - requirements

Project ID:
CTA_-PROD_INFRA-93
Global ID:
CTA-200907
Name:
B-INFRA-0770 Network Connection Availability
Description:
The Network links must operate with an availability of more than 98% to each Telescope during Observations and to each Controllable System during Operation.

Notes:
New Requirement. Note that this also applies to specified Array Common Elements.

There are no requirements on Array Common Element network connections yet !!

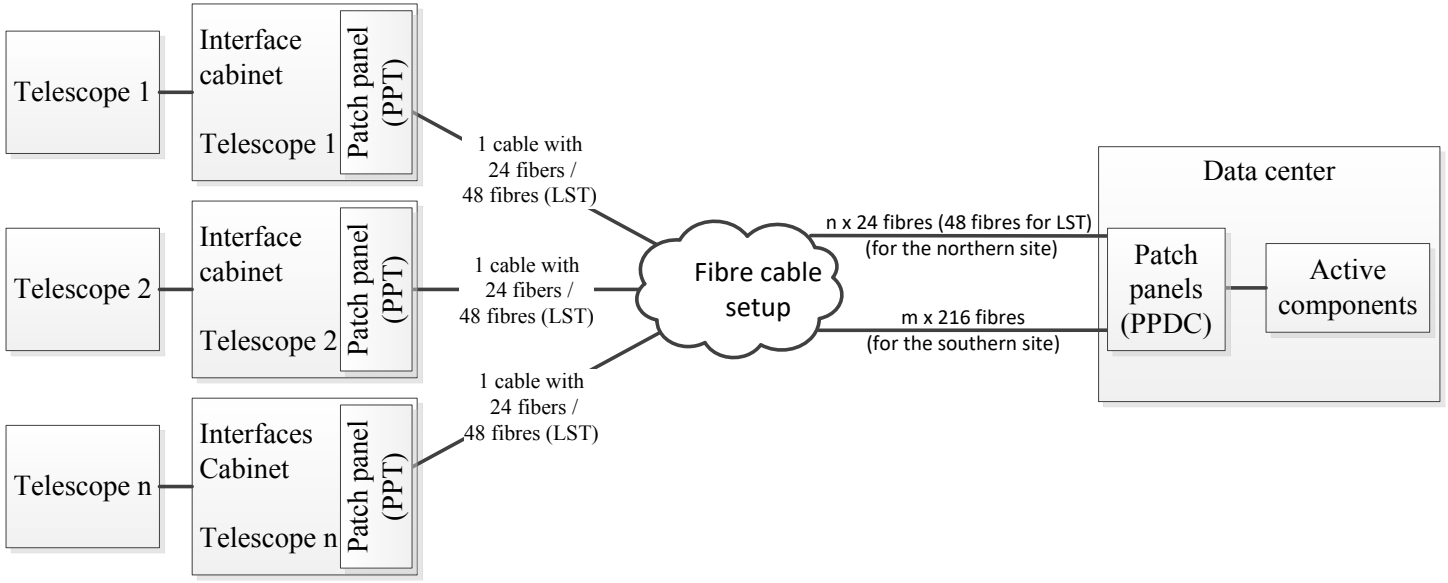
Summary of the Ethernet lines connecting telescopes with the data centre

Number of lines		Name of connection	Rate per line (Gbit/s)		Connection	
					From	To
LST	**MST**		LST	MST		
6	4	Camera	10	10	Cherenkov camera	Camera Servers
1	1	Critical telescope control & monitoring	10	10	Telescope switch	Central Switch
1	1	Clock distribution	1	1	Cherenkov camera	Central Clock Distribution
1	1	Safety & Alarm System	1	1	Interface cabinet	Data centre
1	1	Interface cabinet switch	10	10	Interface cabinet switch	Central Switch
1	1	Additional telescope control & monitoring	10	10	Telescope switch	Central Switch
13	3	Spares	10	10	open	open

Network: Layout & Cable Pathes (48 fibers)

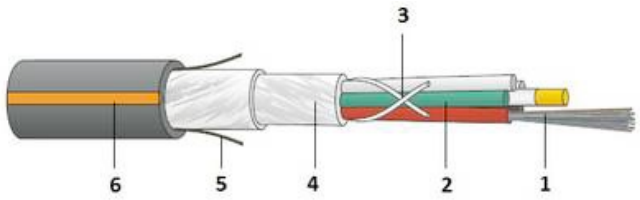
> Cable path and interfaces (datacenter to telescope)

- In the datacenter a patch panel for each telescope will be installed
  - 12 Port LC / Telescope (with light protective caps)
- A 24 fiber cable goes from the data centre through the trenches to the interface cabinet
- In the interface cabinet a 24 Port LC patch panel will be installed



Cable and fiber specification

> Cable choice (Just one type of fibre cables for the whole array!)



- Due to the distance of few hundred meters single mode fibres are required
- Single Mode OS2 cable: 1550 nm and 0.4db/km maximum attenuation
- Outdoor cable single mode cables (non metallic, dry interstices, water resistant, rodent protection, high crush resistance)
- Robust, non metallic, with stranded loose tubes in one layer
- 24 fiber cable (12 connections) A-DQ(ZN)B2Y 2x12E 9/125
  - Sheath diameter 11mm
  - 89 kg / km
- 48 fiber cable (24 connections) A-DQ(ZN)B2Y 4x12E 9/125
  - Sheath diameter 11mm
  - 91 kg / km
- **Cable type ITU-T G.652.D is proofed for White Rabbit**

Fibre production remark concerning reliability

- The type of fibre is defined in the norm ITU-T G.652.D. However, due to the differences between production lines and vendors concerning attenuation and fibre asymmetry, it is highly recommended to have only one production line for each construction phase as this will reduce the number of measurements needed for the calibration of the White Rabbit System

Number of fibres

- Why 48 fibres instead of an appropriate number like 30 or 36?
  - Standard cables are available in 12 → 24 → 48 → 72 → 96 → 144 → a.s.o.
  - Non-standard cables are much more expansive because an extra production lines
- Why we won‘t use 2 cables with 24 and 12 fibres?
  - Two cables with 24 and 12 fibres are more expansive than one cable with 48 fibres
  - Installation of two cables instead of one, costs twice as much
- Estimation of costs:
  - 12 fibre cable: 100 %
  - 24 fibre cable: 120 %
  - 48 fibre cable: 140 %

Cable: Increase number of spare fibres

> North

- 1 x 24 fibres to each telescope → next step 1 x 48 fibres to each telescope
- Doupled number of splices, patch panels, etc. → cost factor 2
- One cable with doubled number of fibres → cost factor 1.2
- **Total cost factor for the cabling is 1.6**

> South

- 1 x 24 fibres to each telescope → next step 48 fibres to each telescope
- 1 x 216 fibres to each patch point → 2 x 216 fibres
- Doupled number of splices, patch panels, installation (216 fibres), etc.

  → cost factor 2
- Cost factor for cables → 1.9
- **Total cost factor is almost 2**

Patch panel

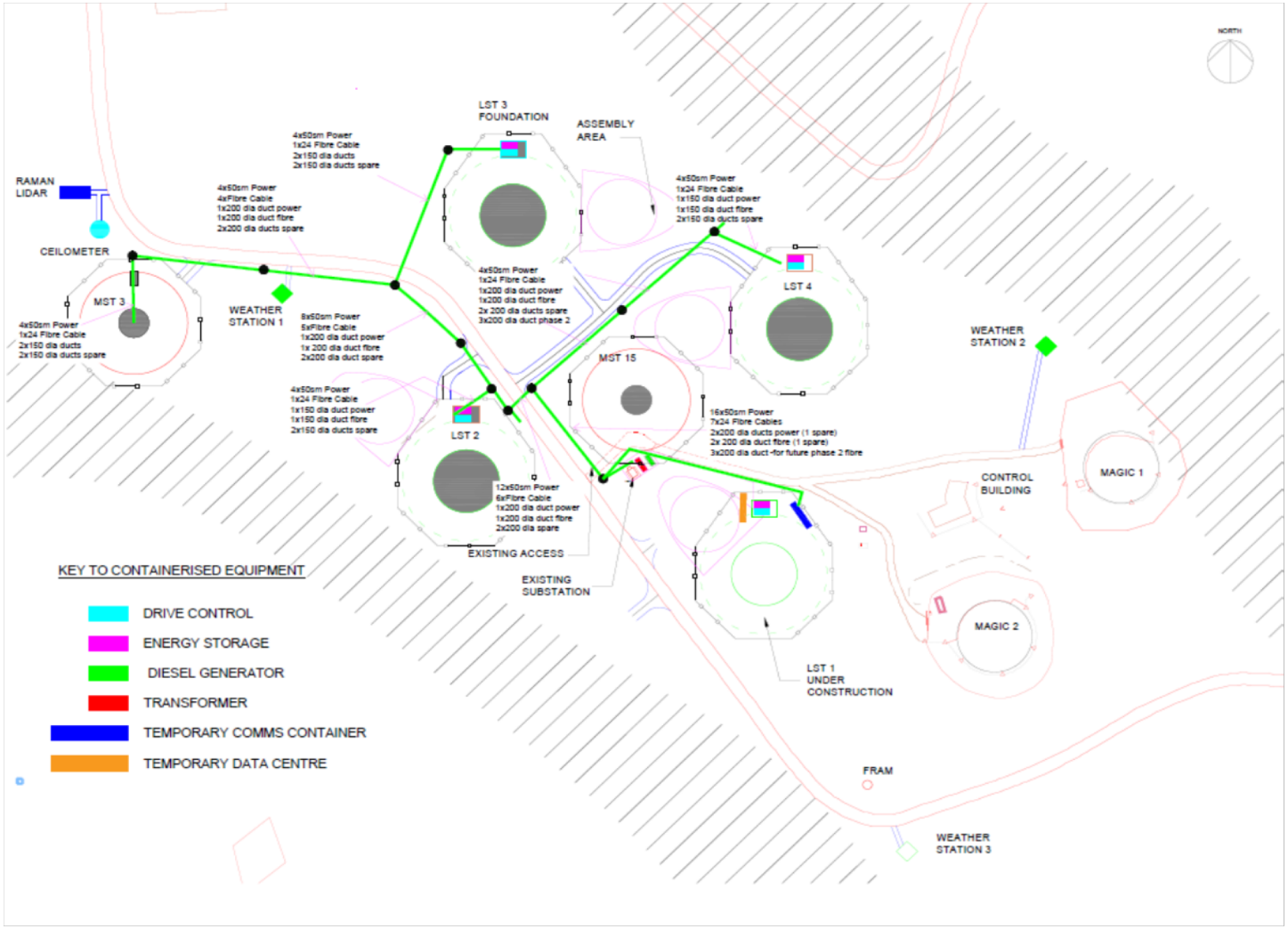
- We recommend to use just one type
  - 24 x LC Duplex, 1 RU
- PPT for LST
  - 24 x LC Duplex in use → 48 splices
- PPT for MST
  - 12 x LC Duplex in use → 24 splices
- PPDC
  - One Patchpanel for each LST → 48 splices
  - One Patchpanel for two MST → 48 splices

Patch panel example picture

What a company needs to know for construction?

- Cable way → To be defined by CTAO
- Cable length → To be defined by CTAO
- Type of cables including the number of fibres → already defined
- Number of Splices (direct between PPT and PPDC or with Patchpoint)
  - We recommend to splice all fibres
    - Not spliced fibres can be damaged by dust or humidity, if they are not protected
- Location of manholes
- Type patch field → already defined
- Appropriate duct types → To be defined by construction company
- Appropriate integration into the data centre → To be defined by construction company

Network Array Topology for the Short Project



Thanks, ...Questions?

Backup slides

Network cost estimation example (ACTL TDR)

Cabling and WLAN Costs		Unit	Costs in €
WBS Item			
3.5	**On-site ICT Infrastructure (ACTL-ONSITE)**		
3.5.2	**On-site ICT Infrastructure South**		
3.5.2.2.2 Array cabling (Datacenter --> Telescopes)			
	SM 2x12E 9/125 optical fibre cables: delivery and install into existing trenches	26000 m	124.800 €
	SM 9x24E 9/125 optical fibre cables: delivery and install into existing trenches	19000 m	163.400 €
	Hood Joint: Delivery, install into existing trenches and label	13 pc	9.400 €
	LWL 12 ports patch panel, deliver, install and label	200 pc	60.400 €
	FRECAP MAX wall fixture, deliver and install	13 pc	13.800 €
	LWL mobile patch cable A/I-VQ(ZN)11Y PUR 2G50/125µm deliver and lay / 46m	100 pc	49.800 €
	splicing work in a tent with overpressure for dusty outdoor splicing	11520 pc	172.800 €
	Check and measure the LWL connections	2400	40.000 €
	Freight & cost of carriage sea transport: material, tools & machines etc.	1 pc	12.500 €
	Freight & cost of carriage road transport: material, tools & machines etc.	1 pc	12.500 €
	miscellaneous costs: documentation, Seal Connector, SE Splice tray,etc	-	29.000 €
	Total		**688.400 €**
3.5.2.3.1 Operation building cabling			
	datacable 800 MHz, FR/LSOH, delivery and install in cable pathes	5000 m	10.000 €
	data sockets 3 ports, RJ45, delivery, install and label	29 pc	1.300 €
	24-port 19" patch panels kat6 RJ45, delivery, install and label	4 pc	1.200 €
	cable runs and trenches, cable protection pipes, constructive elements, etc	-	3.500 €
	Freight & cost of carriage sea and road transport: material, tools & machines etc.	1 pc	1.500 €
	miscellaneous costs: documentation, measure,etc	-	4.000 €
	Total		**21.500 €**
3.5.2.3.2 Technical building cabling + connection to data center			
	datacable 800 MHz, FR/LSOH, delivery and install in cable pathes	2200 m	4.400 €
	data sockets 3 ports, RJ45, delivery, install and label	13 pc	500 €
	24-port 19" patch panels kat6 RJ45, delivery, install and label	2 pc	600 €
	cable runs and trenches, cable protection pipes, constructive elements, etc	-	3.000 €
	SM 2x12E 9/125 optical fibre cable: delivery and install into existing trenches	800 m	4.000 €
	12-ports 19" patch panel LWL SC, deliver, install and label	2 pc	600 €
	Freight & cost of carriage sea and road transport: material, tools & machines etc.	1 pc	1.500 €
	miscellaneous costs: documentation, measure, pig tails, splicing, etc	-	4.500 €
	Total		**19.100 €**

Network cost estimation example (ACTL TDR) cont.

3.5.2.3.3 Residence building cabling + connection to data center			
	datacable 800 MHz, FR/LSOH, delivery and install in cable pathes	3100 m	6.200 €
	data sockets 3 ports, RJ45, delivery, install and label	34 pc	1.400 €
	24-port 19" patch panels kat6 RJ45, delivery, install and label	2 pc	600 €
	cable runs and trenches, cable protection pipes, constructive elements, etc	-	3.500 €
	SM 2x12E 9/125 optical fibre cable: delivery and install into existing trenches	1500 m	7.500 €
	12-ports 19" patch panel LWL SC, deliver, install and label	2 pc	600 €
	Freight & cost of carriage sea and road transport: material, tools & machines etc.	1 pc	1.500 €
	miscellaneous costs: documentation, measure, pig tails, splicing, etc	-	4.500 €
	Total		**25.800 €**
3.5.2.1.4 Data center cabling			
	LWL patch cables several length	700 pc	10.000 €
	Copper patch cables several length incl management network	2500 pc	13.000 €
	24-port 19" patch panels kat6 RJ45	60 pc	12.000 €
	cable guiding panels	60 pc	1.500 €
	Total		**36.500 €**
3.5.2.4 WLAN			
	WLAN cables in buildings, delivery and install in cable pathes	2400 m	4.800 €
	data sockets 2 ports, RJ45, delivery, install and label	26 pc	900 €
	Access Points Outdoor	105 pc	157.500 €
	Access Points Indoor	30 pc	24.000 €
	Controller	2 pc	65.000 €
	Freight & cost of carriage sea and road transport: material, tools & machines etc.	1 pc	5.000 €
	Total		**257.200 €**
Total (South Array only)			**1.048.500 €**