Optical solutions for astronomical data rates

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Transmission challenges in SKA radio astronomy

Very high data rates

Terabits of information

Compression still leaves huge bandwidth

Time critical transmission

Synchronization of several telescopes require minimum delay

Wide spread areas

Covering half continents

Long distances between sites

Missing infrastructure

Areas selected for e.g. SKA are sparsely populated

And what about transmission network build, maintenance and operation?

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Today’s transmission technologies are already prepared for these challenges

Very high data rates

Up to 9.6 Tbps capacity with 100G per channel

True upgrade path to 400G per channel

Time critical transmission

Various synchronization options

Lowest delay and jitter

Wide spread areas

Today up to 2500km without electrical regeneration

Missing infrastructure

Minimum human intervention due to high degree of automation

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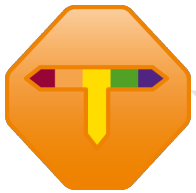
Technology is not the only transmission aspect
Several choices have to be made



Future-proof optical transport technology

For high capacity transmission

Infrastructure (fibre) deployment

Direct buried or aerial

Build, maintain & operate the whole network and infrastructure

Technology & business consultancy to find the optimum choice in terms of best performance and lowest Total Cost of Ownership

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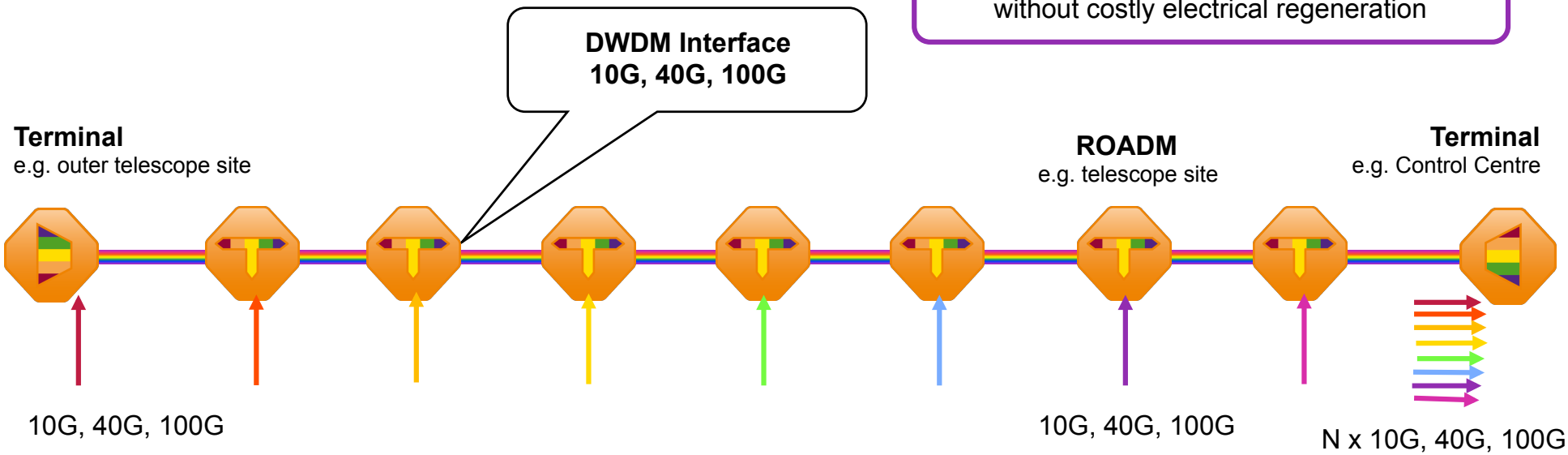
DWDM is the only technology to cope with radio astronomy challenges

Reach: from metro reach to > 2000 km without costly electrical regeneration



10G

- Mature technology, widely deployed
- Mass market prices
- Requires fibre rich infrastructure
- Huge amount of equipment needed (OPEX: floor space, power consumption)

40G

- Ramp up started now, fast price decline
- Less fibre, less equipment (OPEX)
- New modulation formats (CP-QPSK) for increased reach, robustness against physical effects and reduced delay

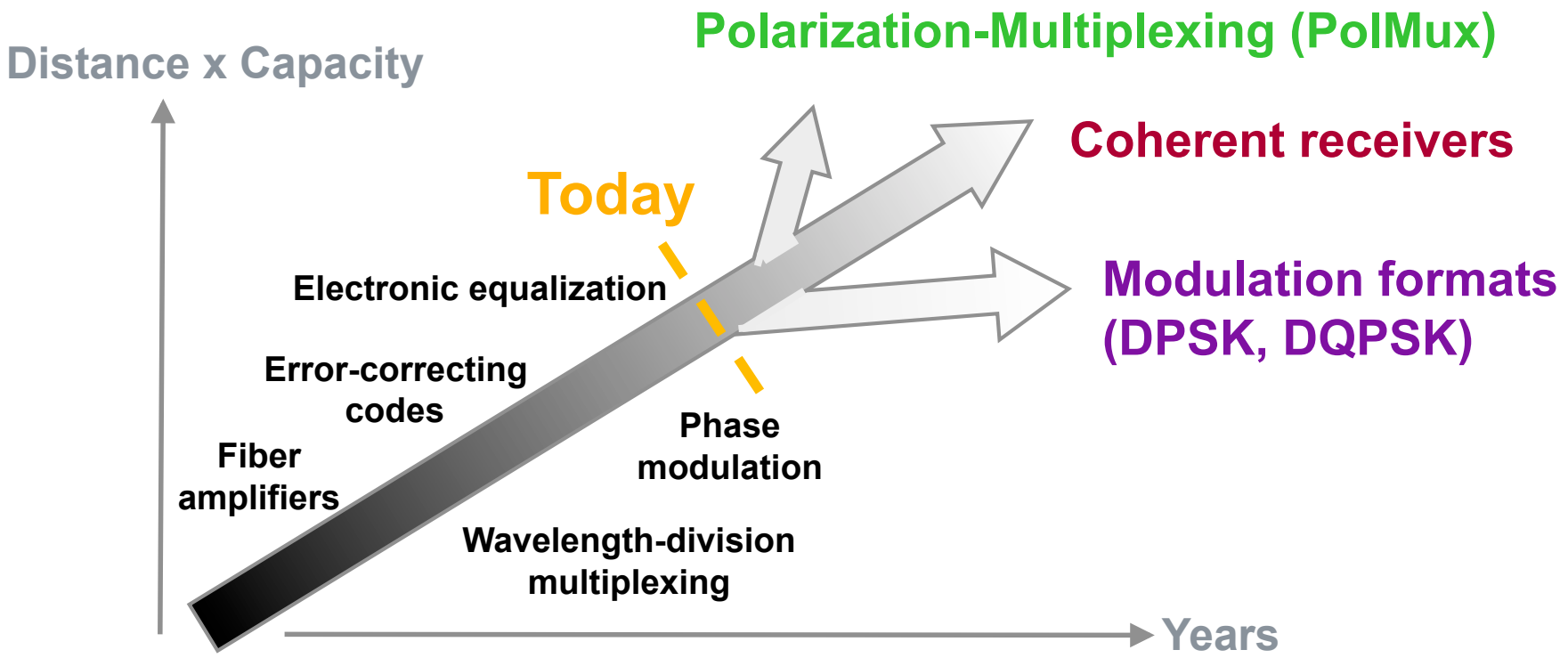
100G

- Currently mainly trials
- Significant deployments expected to start in 2012
- Lowest fibre count, lowest OPEX
- Same reach as with 40G

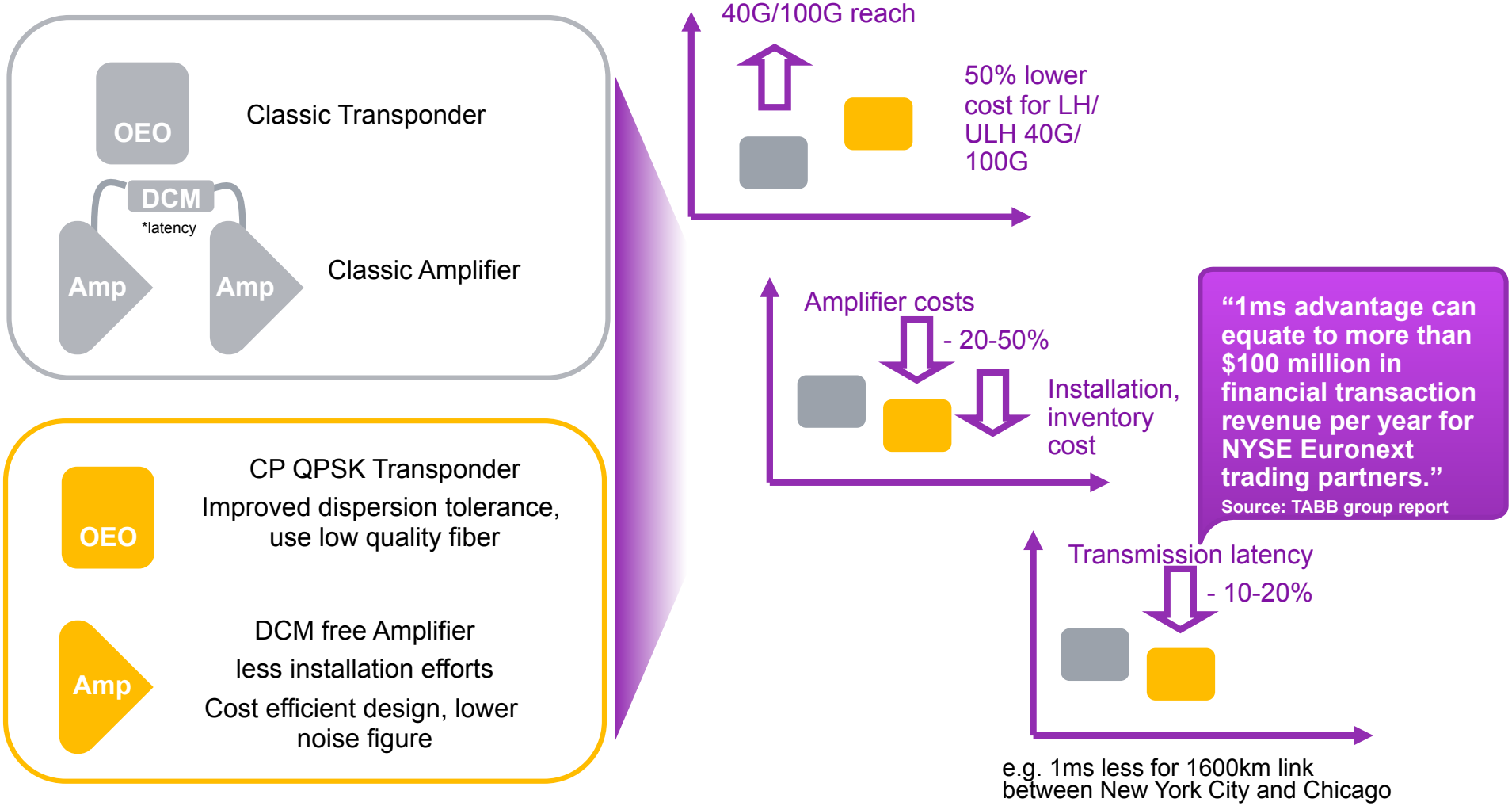
DWDM: Dense Wavelength Division Multiplexing

ROADM: Remotely re-configurable Optical Add Drop Multiplexer

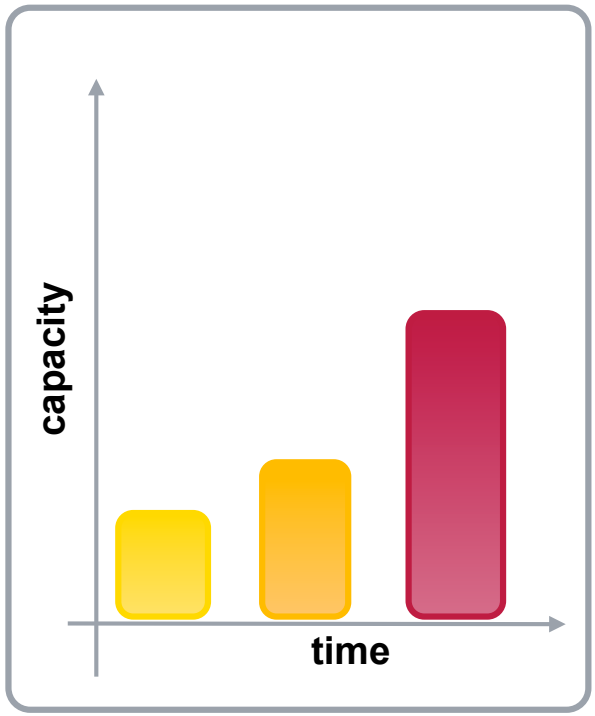
The way to 40G/100G offers different technology possibilities



@ 40G/100G, coherent transmission guarantees lower cost/bit and latency



Nokia Siemens Networks is a leader in capacity



Speed
- Single carrier 100G in 2011

Capacity
- 9.6 Tbit/s with 96 channels

True upgradeability
- 10G → 400G in one system
- 100G planning can be done now

2006	2006	2007	2008	2009	2010
First to mass-rollout 40G	First 107G field trial with AT&T	First 100G CP-QPSK lab trial	First 100G CP-QPSK field trial	5000 40G ports shipped	CP-QPSK commercial available

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How does the picture look in future, e.g. after 201

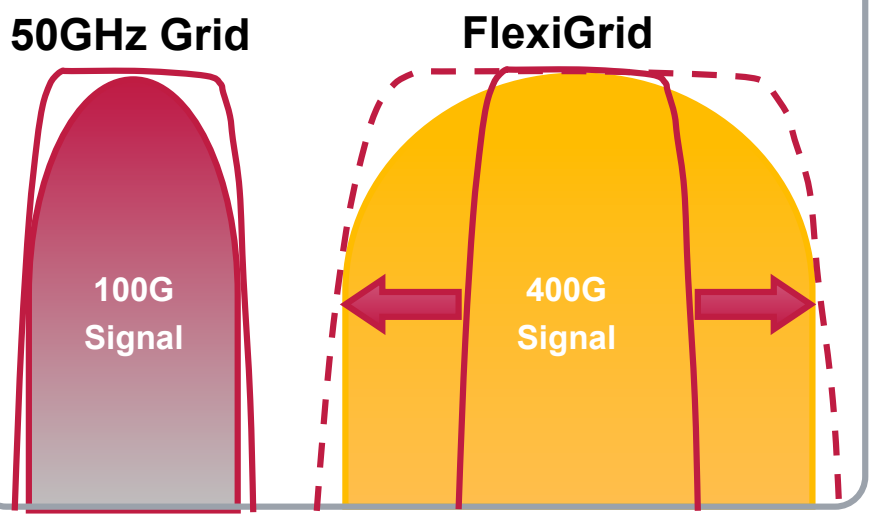
Technology evolves beyond 100G

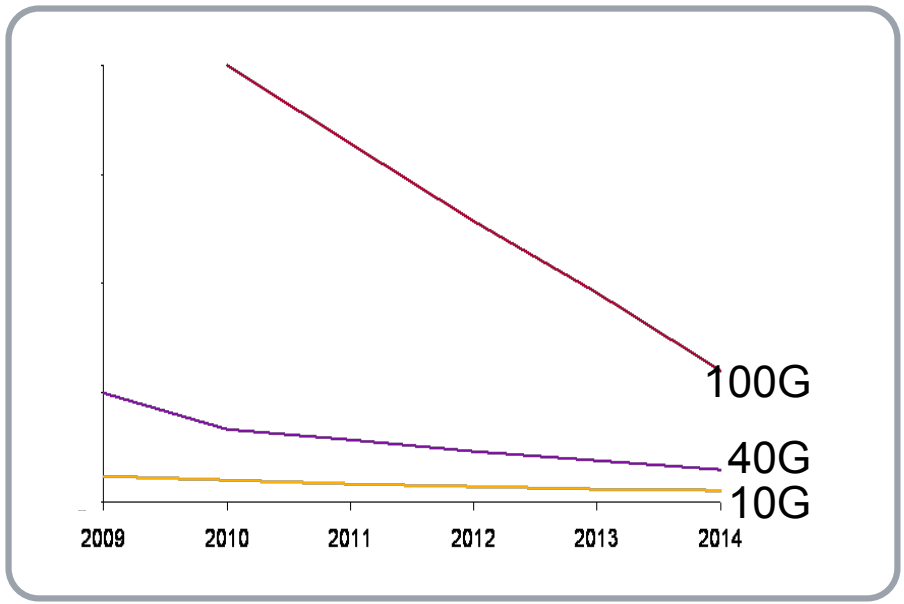
- 400G+ signals do not fit into 50GHz wavelength grid
- FlexiGrid dynamically adapts wavelength grid to actual need of each channel

Interface market strongly decline

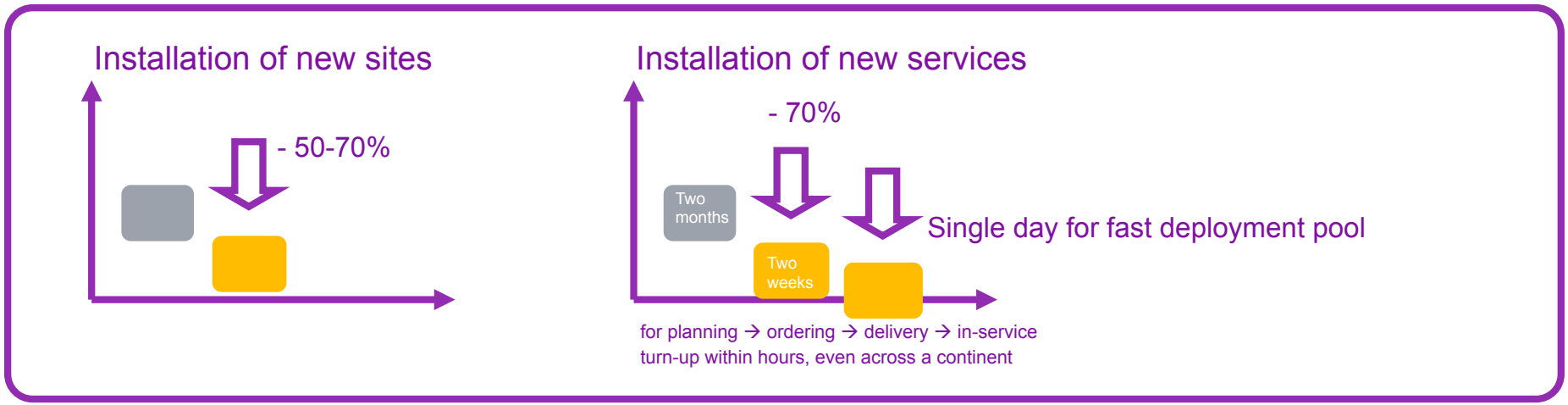
- In a few years there will be a mass market for high speed optical interfaces
- Price decline starts with mass market roll outs

Dynamic adaptation of wavelength grid



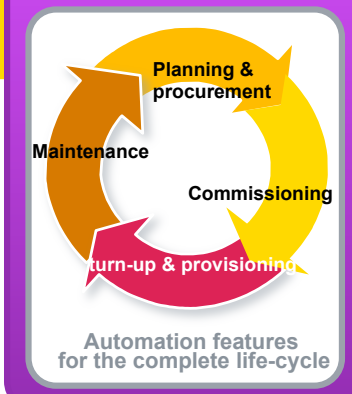


Capacity is just one aspect: Speed up installation and service provisioning



Rack&stack

- Deliver fully assembled, commissioned, tested racks/sites
- 100% fault-free delivery
- Installation time < ½ day



Automation

- Automated link turn-up, channel up/downgrade, routing and switching,
- Data E-flow planning → commissioning → operation

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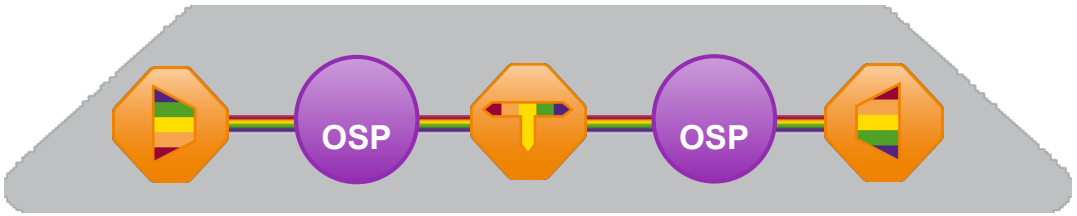
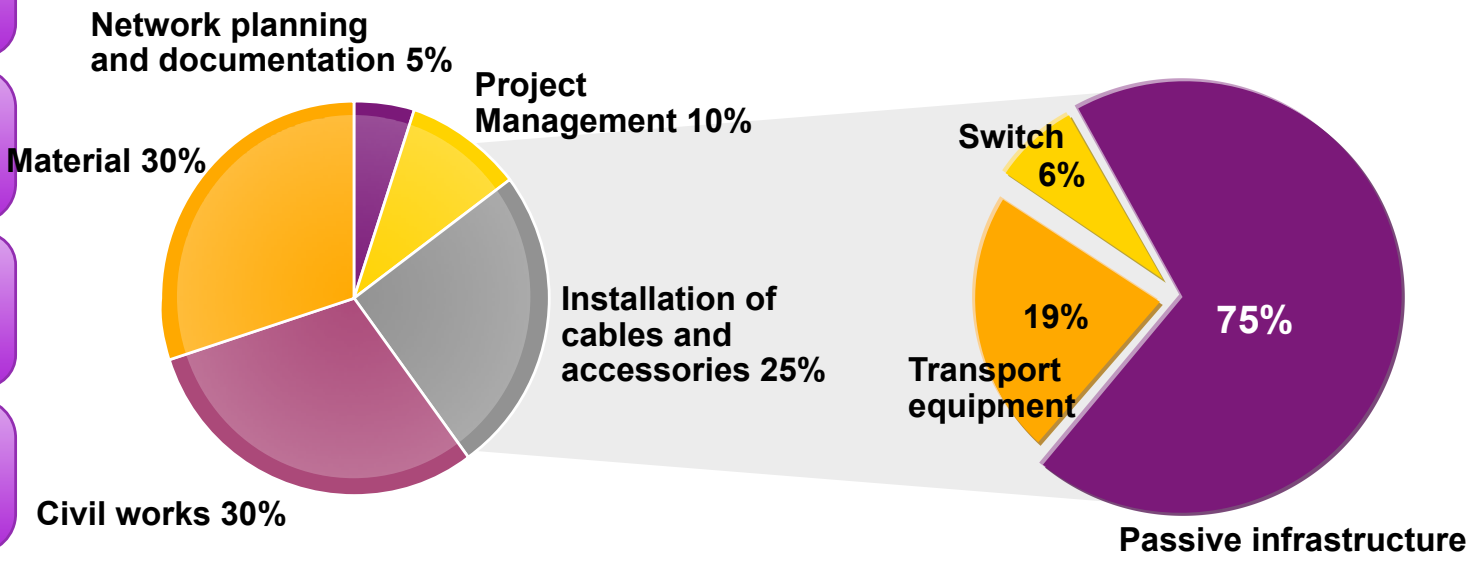
Outside Plant (OSP) covers the entire passive network infrastructure

- Network planning and engineering
- Partner and product selection and certification
- Project management
- Delivery and Logistic
- Deployment of Civil Works & Network Solutions
- Consultancy





There are various phases of infrastructure deployment

Pre-Survey Backbone → Demand Analysis → Survey → Acquisition of Maps → Design & Planning → List of Material

Surface



Soil Class

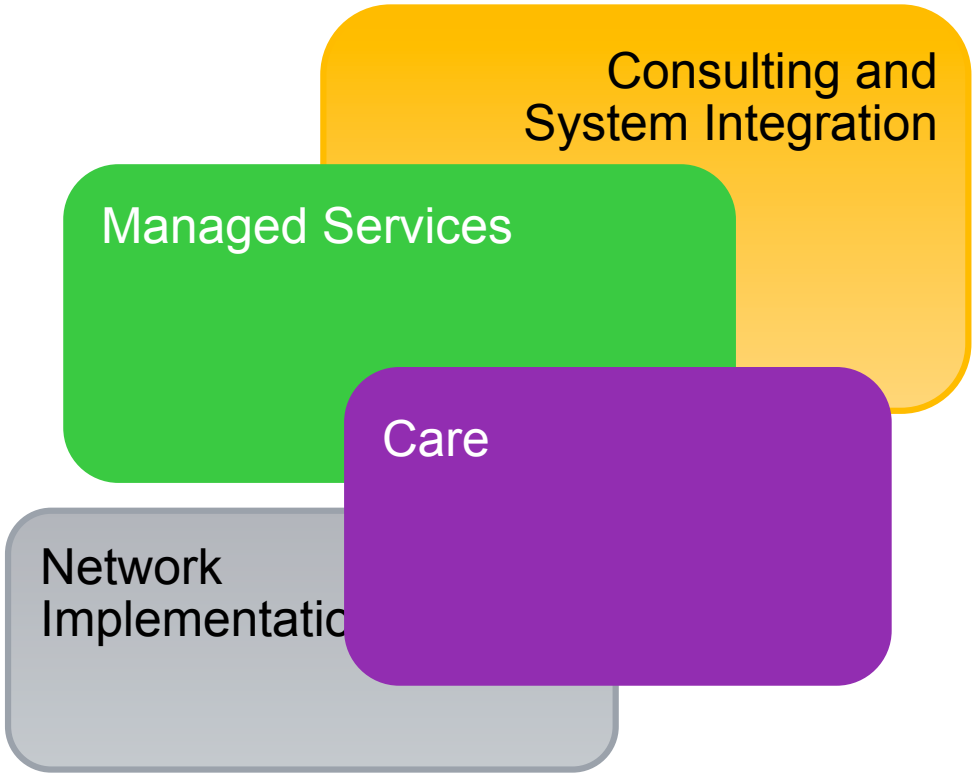









Your core business is radio astronomy
But you need to transmit and process data



You don‘t need to care about

- Finding the optimum solution
- Build the network
- Maintain the network
- Operate the network

You benefit from

- Global support whenever and wherever needed

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But first of all you need to analyze the optimal options for you

Input data from SKA

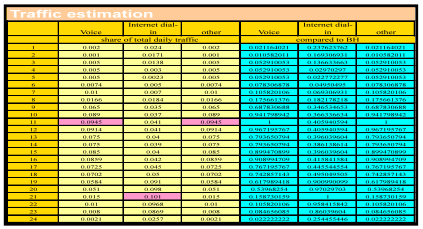
Topology

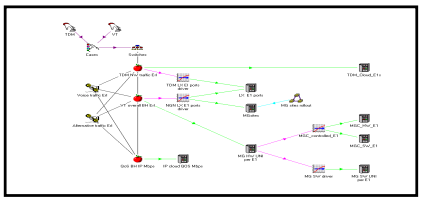
- Exact placement of radio telescopes and control centre
- Information about soil structure

Bandwidth

- Bandwidth per node to be transported
- Bandwidth evolution over time

Tool generation and modeling process



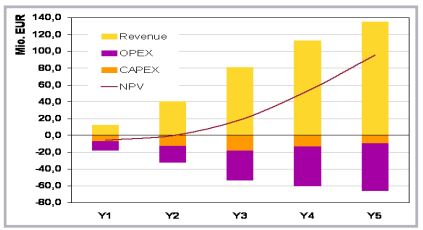


Data analysis, Value Based Argumentation

Key financial results, e.g.:

- CAPEX
- Power per bit
- Fibre to rent vs. own fibre

- Sensitivity analysis of specific input parameters



There are several options in all areas: technology, infrastructure and network maintenance & operations

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Optimize the optical solutions for radio astronomy

Technology

Flexible capacity: 10G, 40G, 100G and beyond

Cost efficient deployment of capacity

Minimum delay

Fast time to market

CAPEX consultancy: Fibre rich 10G vs. 100G; Own fibre vs. fibre to rent; Aerial cable vs. buried cable

OPEX consultancy: Power per bit per km, Own operation of network vs. outsource operation

TCO evolution over time

Infrastructure (fibre)

Various deployment options and business models

.. All of them depend on physical parameters

Network build, maintenance & operations

“One stop shopping”

You can focus on your core business

Thank you

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With our Global Services Support and footprint we can support you anytime

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GNSC Portugal
(Lisbon)

GNSC India
(Noida)

GNSC India
(Chennai)

- **Local service management and customer relations** provided through NSNs system and operating experts
- Cost-effective solutions through **centralized/ shared activities of the NSN LNOC and GNOC**
- **Availability of experts 24/ 7/ 365**
- Appropriate **transmission back-up and security** measures

GNSC – Global Network Service Center

Local Operation

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