Network

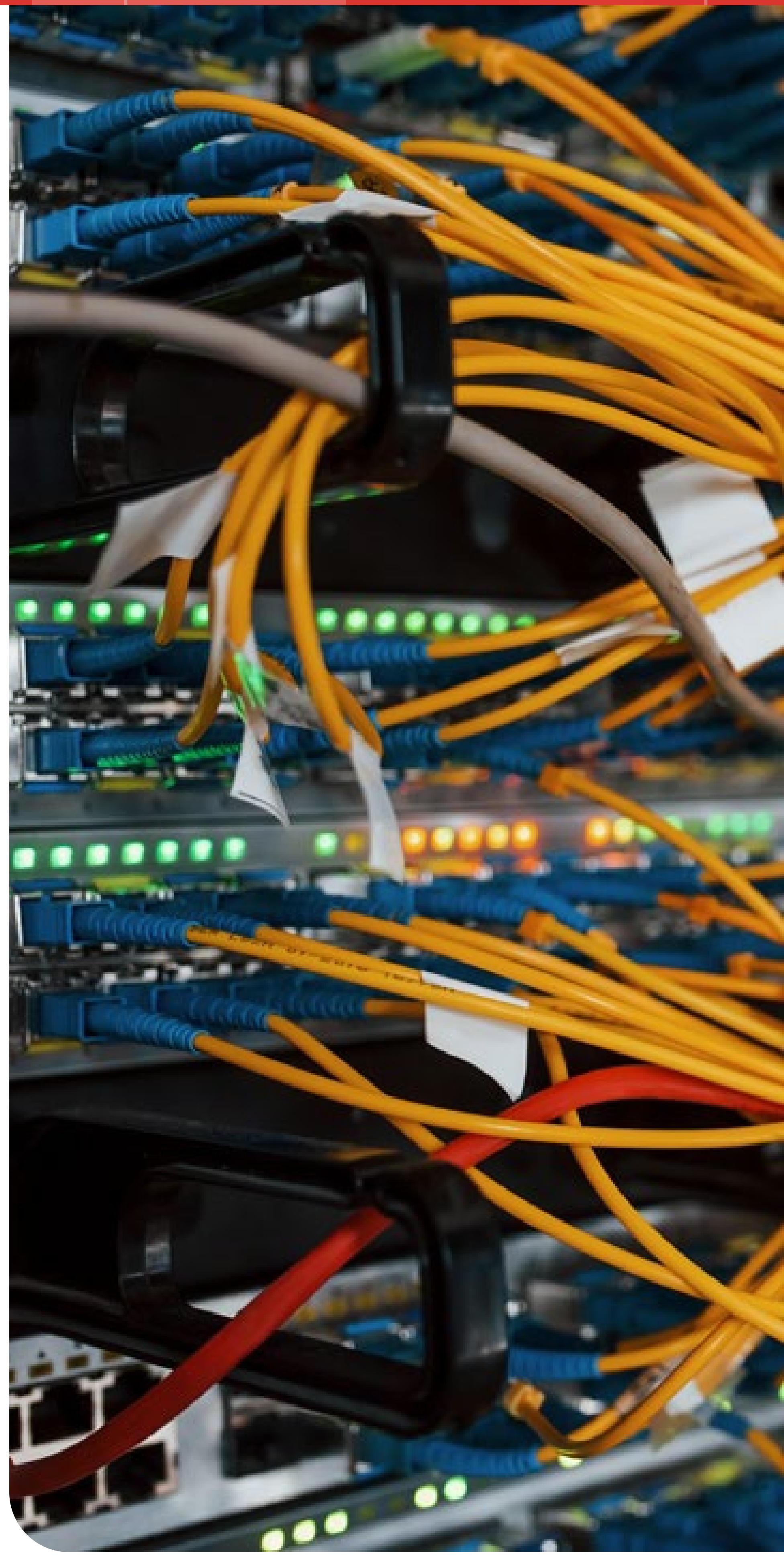
- Big Tech and networking
- Intelligent networks
- Edge and campus architecture
- Next generation networks

Network technology

Fixed communication networks are essential for the digitalisation of society in the Netherlands. Networks also integrate compute and storage more and more. Cellular, Internet and data centre worlds are overlapping more and more. Together, these networks form the foundation for internet applications, (research) services and cloud. Without a suitable network these applications, services and clouds would not function properly. National Research and Education Networks (NRENs) provide appropriate connectivity allowing students, teachers and academics to collaborate without boundaries.

Communication networks are essential for research and education in the Netherlands and for increasing global collaboration. These networks not only facilitate digital communication for many students and researchers, but also enable innovation in all areas of expertise, from climate science to health science to radio astronomy. In addition, fixed communication networks are essential for addressing major societal challenges, for example in the field of sustainability and safety. The landscape of an NREN is changing continuously to facilitate new and improved applications and technologies, such as campus integration, XR, edge computing, quantum, etc. Some trends offer opportunities, while others represent risks and challenges. This chapter describes the trends that we see in the fixed network landscape.

Network technologies can be viewed from different angles. In this chapter we focus on fixed networks; the other perspectives, such as wireless (LoRa, WiFi, etc.) and non-traditional use of network infrastructures (quantum, etc.) are out of scope.



TREND #1

Big Tech and networking

Public values

Autonomy	Freedom of choice | Self determination | Independence of education | Safeguarding of private life and personal data
Justice	Integrity
Humanity	

Readiness	WATCH PLAN ACT

Drivers

#Open science #EU legislation #Privacy #Data governance #Open-source development #Globalization

Big Tech companies and cloud providers are expanding their worldwide dominance by acquiring ever more physical infrastructure and introducing innovative techniques focusing on operating and facilitating their services even better. While these companies already own content and data on the internet, these strategies allow them to own the physical network infrastructure and services as well. Due to Big Tech's monopoly and the lack of feasible and ubiquitous alternatives, innovation initiatives by other parties to improve security, stability and transparency of the internet are less likely to succeed. Broad collaboration is required to change course and safeguard our digital sovereignty.

Strengthening digital sovereignty makes Europe less vulnerable, both politically and economically

TNO provides options and ideas to strengthen digital sovereignty, taking into account European initiatives. Those options include new legislation and the development of European alternatives, through state-supported investments and collaboration.

open example

Big Tech's next act will be to evolve into networks

Big Tech companies are teaming up to deliver networking capabilities. Facebook and Google announced they were funding two trans-Pacific cables connecting the US West Coast to Singapore and Indonesia.

open example

2STiC: security, stability and transparency in inter-network communication

A joint research program in the field of trusted and resilient internet infrastructures helps putting the Dutch and European networking communities in a leading position to enhance the security, stability and transparency of internet communications.

open example

Big tech conquers internet infrastructure

Big Tech companies (Meta, Microsoft, Amazon Alphabet) are expected to become the largest shareholders in the submarine cable market in the next three years.

open example

IMPACT

Big Tech companies and cloud providers are able to deliver high quality services due to their level of integration. Researchers, students, IT managers, teachers, etc. find this level of service convenient and place ever more trust in one provider. Ultimately this poses a risk as users become dependent on one or a small number of parties. Free and open science, access to data and unrestricted usage of the internet, may become less self-evident.

TREND #2

Intelligent networks

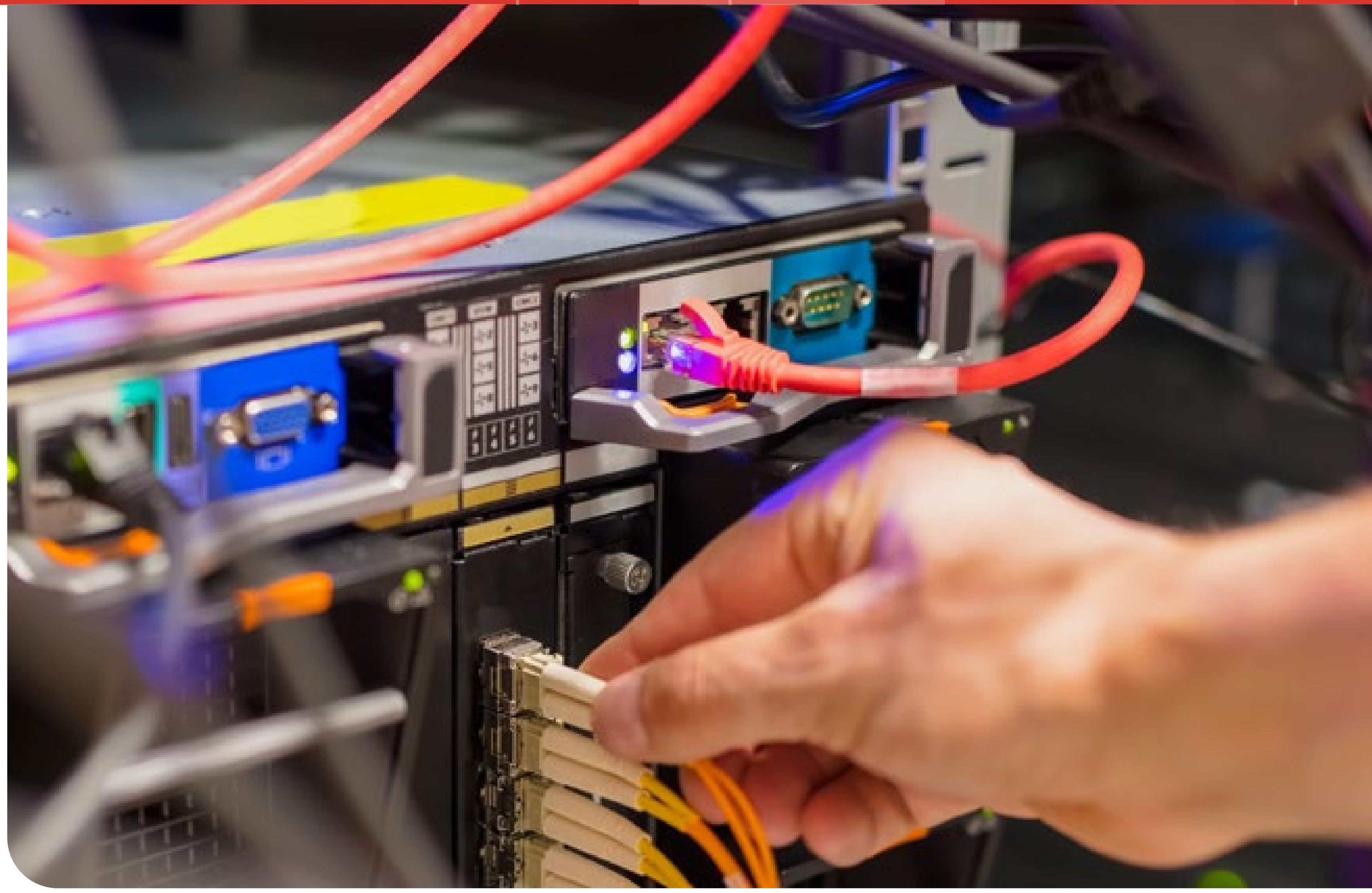
Public values

Autonomy	Freedom of choice | Self determination | Independence of education | Safeguarding of private life and personal data
Justice	Integrity
Humanity	

Readiness WATCH PLAN ACT

Drivers

#Data governance #Automation #Cybersecurity



With the emergence of ever more service-orientated architectures in software, we see that the operation of networks is evolving as well. Networks need to be more flexible, open and programmable; moreover, they need to be defined around a service that the provider is delivering to a customer. To enable this, network provisioning is evolving from manual and/or device specific provisioning to service provisioning through APIs, across multiple network components with different functionalities. This allows the network to be integrated with other infrastructure like compute and storage. Intelligence can be added to the network by leveraging telemetry, artificial intelligence and machine learning algorithms. These additions can modify the network through the defined services to fix anomalies, optimise service delivery and improve security. These additions can modify the network through the defined services to fix anomalies, optimise service delivery and improve security. Network developments are also relevant and needed to support the further development of AI/ML.

Creating a Smarter Network

Several NREN networks enable on-demand data feeds between researchers and scientists. Scientists are able to schedule large data transfers via multi-domain, high-bandwidth virtual circuits that guarantee end-to-end network performance.

open example

Cloudflare outage - Cloudflare

Outages at Cloudflare affected 19 data centers, which handle a significant proportion of global traffic.

open example

IMPACT

Intelligent networks provide users, such as students, scientists and operational staff, with network functionality that matches their needs. This allows users to make better use of network resources due to integration of services (e.g. compute, storage, …) or automatic recovery in case of incidents. Service provisioning is guaranteed to be fast and secure as human error is eliminated.

The introduction of data plane programming makes it possible to research and design protocols and APIs to increase our insight in the network and utilise resources more efficiently. However, with the emergence of this trend operators run the risk that running networks becomes even more complex. By introducing intertwined architectures and high levels of automation and orchestration, the network layer and application layer become highly interdependent and therefore increasingly impact each other. Programmability can facilitate the integration of automation tools.

TREND #3

Edge and campus architecture

Campus network operators are experiencing a brain drain of employees who are willing and able to run networks. SURF and their members can help universities to select a network architecture that scales well, is very robust and secure by design. At the same time, the services that need to be delivered at the network edge or on campus are getting increasingly complex. As a result, various technologies are increasingly being applied to campus and edge networks to ensure service delivery. Examples of these technologies are: NFV, SD-WAN, 5G/hybrid cloud infrastructure and EVPN-VXLAN.

Public values

- **Autonomy** — Independence of education
- Justice
- Humanity

Readiness: WATCH | PLAN | ACT

Drivers

#Automation #Connectivity

CNaaS - SUNET, SIKT, Nordunet

Development of a concept and toolkit for an NREN to provide a 24/7 secure and highly reliable campus network service for campus networks.

open example

As 5G, Edge computing and hybrid multiclouds converge, industries will be transformed

The emergence of edge computing and the telecommunications network as a hybrid multi-cloud platform. The combination of 5G, edge computing and hybrid multi-cloud represents a new computing model capable of transforming a wide range of industries.

open example

The AI driven campus architecture

Network architects are redesigning their networks to accommodate modern business requirements of cloud-ready applications for data, voice, and video, using open standards and software-driven management platforms to reduce operational costs. The ultimate goal is to leverage simpler automation, telemetry, and AI capabilities to expand the network of the next decade.

open example

IMPACT

This trend allows campus operators to focus more on end-user services and less on the underlying technology. The underlying edge and campus technology can be highly standardised and integrated with other infrastructures and applications. This combination allows small operational campus teams to run networks that serve a variety of end-users. In addition, this integration ensures innovation and new opportunities may arise in due course. Edge and campus networking includes many components and potentially a lot of third-party suppliers. This operational model and architecture require well defined SLA's, agreements and trusted parties.

TREND #4

Next generation networks

Public values

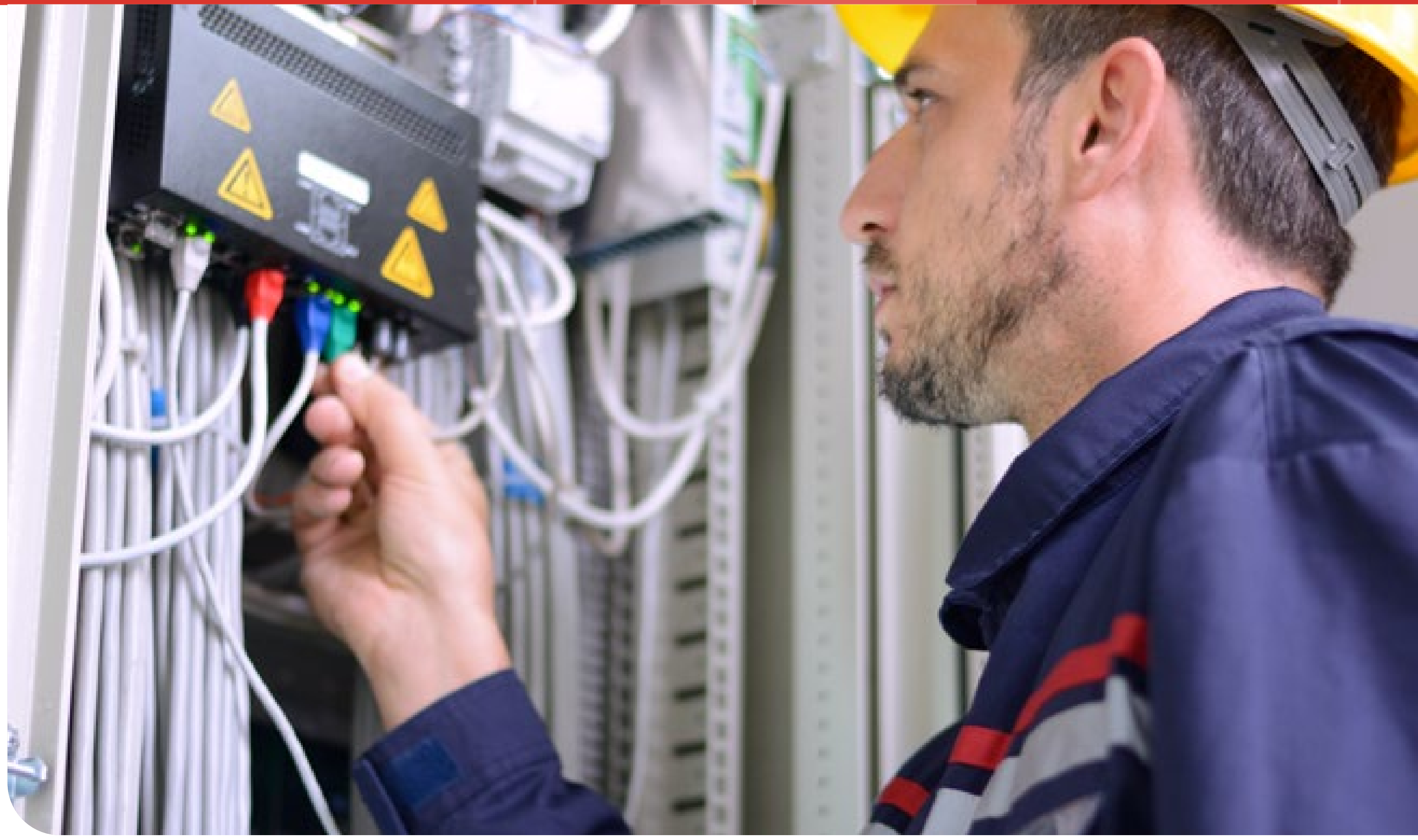
Autonomy	Independence | Freedom of education and research
Justice	Integrity
Humanity	

Readiness WATCH PLAN ACT

Drivers

#Connectivity #Datagovernance #Cybersecurity

Numerous examples show that the amount of data being transported is increasing every year. Vendors of network hardware are focusing on these increasing demands in their hardware design. National research and education networks (NRENs) must be able to support all types of traffic on their network. Examples are regular internet and campus traffic, latency sensitive flows, data intensive flows and other research traffic. This is usually not the case for normal network providers, therefore technology that an NREN requires may not be incorporated in future chipsets.



SKA: network requirements

Next generation network requirements for the Square Kilometre Array project. Multiple redundant large networking pipes are expected to be needed to and from various locations worldwide from the start of the project. NRENs need to collaborate to provide the required connectivity.

open example

ITER: network requirements

Next generation network requirements for ITER; one of the most ambitious energy projects in the world. Multiple 100Gbps connections are expected in the first years of operations.

open example

Global internet bandwidth - the era of networking measured in petabits

Over the past few years the internet traffic has increased with an annual growth rate of 29%.

open example

ITU-T Technical Report - Use Case: Huge Scientific Data Applications (HSD)

Towards the year of 2030 and beyond, many novel applications are expected to emerge as others mature, leading to increasingly intertwined human and machine communications. New applications often trigger new services and introduce challenging requirements that demand the continuous evolution of networking technologies. Thus, the inherent capabilities of interconnected networks and the running principles therein need to be enhanced, or even replaced, as requirements unfold.

open example

HL-LHC: Network Requirements and Associated Issues

The Large Hadron Collider in Geneva demands next generation network requirements. The amount of data that needs to be transported is expected to increase tenfold in the next five years.

open example

IMPACT

Large-scale research projects enable the development of next generation networks, not only by facilitating bandwidth requirements, but also by enabling new network applications, protocols and architectures. This will accelerate the commoditisation of new integrated services, increase sustainability and trigger vendors to build suitable hardware.

More about Network

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