Connectivity Essentials and Universal Access as a basis for AfCFTA competitiveness in the Post-4IR Global Economic Era

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1. Introduction

The gazetting of the national system of innovation (NSI) in South Africa sensitized scientific institutions to sharing with the state, a responsibility to developing scientific impacts through skilling and innovative research, since 1996 (DST, 1996). Institutional operational transformations have since emerged, with universities leapfrogging beyond the traditional academic formations of Teaching and Learning (T&L) and Research - merely for the sake of doing so, to including Community Engagement (CE), coupled with (i) *Relevance* and (ii) *Impact* pursuits as well as practical problem-solving innovations. The University of South Africa have since added (iii) *Internationalisation* and the (iv) *Africanisation* commitments to this equation. Needless to state, these are boldly underlined in a mission undertaking to "Defining Tomorrow" (UNISA, Online) coupled with eagerness to "Shaping the Futures" (SBL, Online). The 1st International Engaged Scholarship conference, with a focus on the Africa Continental Free Trade Area (AfCTA) epitomized these four prerogatives (SBL, 2022).

Chief among its objectives, AfCTA seeks to combine the disaggregated African markets into the largest (by number of participating countries), single market – with a competitive edge in the global economic landscape.

Digital readiness in the form of broadband capacity, universal access, a culture of innovation and entrepreneurship is central to almost all development activities in the information age, with AfCTA not being exempt to this rule.

1.1 Rationale

In this lecture, the author interrogates the AfCFTA initiative, in terms of ICT connectivity-readiness to effect its transformative ideals, competitively in the global economic landscape.

The objective is to understand the status of ICT infrastructure development among AfCTA member states in capacitating AfCTA economic competitiveness in the global networked economy. However, infrastructure development projects within the AU2063 are implemented by Pan African e-Network (flagship project 10). Hence, ICT connectivity development priorities of flagship 10 – are the unit/s of observation in this project.

Mostly, since:

- ✓ the 15 AU Agenda 2063 flagship projects are inter-dependant.
- ✓ Positive or negative developments in the African Commodities Strategy (flagship project 2), Establishment of the African Financial Institutions (flagship 9), and the Pan African e-Network (flagship 10) for example – would have a direct effect on AfCTA implementations
- ✓ Unless the ICT connectivity infrastructure evolves positively, the likelihood of AfCTA objectives being realized is diminished

1.2 Question

Given the essence of technology connectedness in national, regional and continental readiness to trade competitively in the networked global economic landscape, what is the status of technology infrastructure development, and technological connectedness among AfCTA member state?

The status alone however, may not translate universal access needed to effect a competitive advantage for long-term sustainability. Thus, questions of network distribution between regions, countries, rural vs urban penetration, as well as aspects of universal access, affordability – are also interrogated

2. Methodology

The author drew on the "Critical Theory of Technology" by Andrew Feenberg (1999) to guide a conceptual / philosophical outlook on technology purposes, implementations and uses. Theoretical insight is then captured in the 4IR, the underlying IoT, and the network society discussion – preceding an outline of the connectivity status. Data on the Infrastructure and Energy Commission of the AU is drawn upon to address the status question. Such operational plans are assessed against the 4IR and the Networked Society characteristics to ascertain efficacy towards AfCTA 4IR readiness.

The data into this discussion is of a descriptive, qualitative, and mostly interpretive in form. Obviously, the 4IR and the AU development priority Areas, offer a contextual outlook into the time and space where the greater AfCTA undertaking is located. The Activity Theory is drawn upon for a framework to guide AfCTA ICT connectivity deployments, in contribution towards AfCTA connectivity readiness.

A snapshot on thinkers in the (i) philosophy of technology, and in the (ii) technology deployment discourse below – puts further discussions into perspective.

3. Influential Scholars

Lecture topic was influenced by:

(i) Own discipline research
(ii) Author's work on Telecoms liberalisations and e-Readiness assessments with Bridges.org (2001-2005);
(iii) AU AfCTA Launch in 2017 & the 1st International Engaged Scholarship Conference (SBL, Aug'22);
(iv) Engaged Scholarship prerogatives – T&L, Research, CE, +Impactful-Ness & Innovations (R&I), Relevance
(v) Internationalisation and Africanisation (SBL & UNISA)
(vi) Urge to ensure that one's work helps to "Define Tomorrow", and "Shapes the Futures"
(vii) Insight from the work of Influential Scholars (Table 1).

Table 1: Influential Scholars

Critical Theory of Technology	Activity Theory	AfCTA ICT Connectivity Status
✓ Technology Achievement Index – Incekara, et al, 2022 ✓ Electromagnetic Hypersensitivity (EHS), Galazzo, R. 2021 ✓ **IoT** - Anttiroiko, 2015, Motlagh, et al, 2020 ✓ **ICT Connectedness** - Srinivathan, et al., 2019 ✓ **Networked Society**: Castells, 2004 ✓ **CTT**: Andrew Feenberg, 1991. 1999, 2003, 2014 ✓ **CTT**: - Pre-shaping of Technology, by technocratic agents that presided over its creation): Mercuse, 1964 ✓ **CTT** – Culture, language & Ideological embeddedness: Pickering, 1992 ✓ **CTT**: Czeniewicz, et al, 2005. ✓ Science in Action; ANT: Bruno Latour, 1987, 1992 ✓ Frankfurt STS: Horkheimer, 1995	✓ Miettinen, 1997 ✓ Engeström, 1987; 1990 ✓ Leont'ev, 1978 ✓ Vygotsky, 1978 ✓ Kuuti, 1991 ✓ Bødker, et al, 2004 ✓ Korpela, et al, 2004	✓ AU Agenda 2063 Reports. ✓ Infrastructure: Abou-Zaid, 2021 ✓ Connecting Africa Through Broadband -World Bank, 2019 ✓ Electricity access - IEA, 2019 ✓ Africa Broadband Status reports - ITU, 2019; ITU, 2021 - ICT status reports - PIDA1 (Abou-Zaid, 2021) ✓ PICI ICT Priority project, 2021 ✓ 1G – to 5G Timeline: Galazo, 2021 ✓ Rural Internet networks - Van Stam & Van Greunen, 2014 ✓ Broadband Connection Points - Afterbridge, 2019.

Subsequent to the Critical Theory of Technology as a conceptual framework, the Activity Theory (AT) is drawn upon to exploring the AfCTA activity focused ICT connectivity project.

4. The Critical Theory of Technology (a conceptual lens)

A scholar on technology study, Andrew Feenberg, undertook a critique on the Frankfurt School of Technology Studies (STS) philosophical assumptions on the essence and uses of technology**.** Drawing on Bruno Latour's Actor Network Theoretical (ANT) foundations, placed computerised technology uses into 4 contrasting categories: (i) Determinism, (ii) Instrumentalism, (iii) Substantivism, and (iv) the Critical Theory of technology.

Table 2: Critical Theory of Technology

Technology is	Autonomous	Human Controlled
Neutral Complete separation of means to Ends	**Determinism** e.g. modernization theory	**Instrumentalism** Liberal faith in progress
Value Laden Means form a way of life that includes ends	**Substantivism** Means & ends Linked in a system	**Critical Theory** Balance of alternative means-ends systems

Andrew Feenberg (2003), "What is Technology", Lecture for the Komaba undergraduates, June (2003), in www.rohan.sdsu.edu/faculty/feenberg/komaba.htm

4.1 Technology Determinism

The determinist perspective sees technology as neutral and autonomous, but not humanly controlled. It describes technology as a determinant of progress and an agent (or determinant) for change (Feenberg, 2003). A number of constructivist educational theorists who see technology as an agent for change fall under this category. It is a modernization tool seen to enhance deployment processes. It breaches many walls created by distance and time zones. It unites people and create powerful and synergistic partnerships at local, regional and global scales; it motivates workers and energizes workspaces (Czerniewicz, Ravjee, and Mlitwa, 2005).

From a neutrality assumption however, technology is not influenced by culture, ethics and profit motives of technocracy, for it is **Autonomous,** and has no influence on the user (Table 1). From the ANT lens, it is equally an actor, *albeit* a neutral one, in a network. It is just an advanced determinant of progress, that must be accepted and used as is (Feenberg, 1999). Such assumptions deny any cultural and language influence that could find expression in different applications and programmes, depending on who programmed it, and where. Blinded by a modernity hype, proponents would dictate models - often condemning users into passive recipients of gadgets, systems and programmes, with no critique on relevance to their own language, culture, health and analytical needs. It is a careless perception that have seen developments "doing to" rather than "doing with" people in deployment environments. A result however, has been an unwavering faith to existing computers and telephone brands, in the name of modernity. Need consciousness, cost effectiveness, relevance and sustainability considerations are disregarded by default.

Technology determinism finds expression in statements such as "computers" or rather, "the 4IR" revolutionises life… it can transform Africa, etc, thereby relegating human agency in the change process, into secondary status. Disguised as neutral technology agency, the profiteering technocratic agency as the real culprit - giggles all the way to the bank with licence fees and escalating "airtime" costs all around the necks of unsuspecting users. Deterministic sentiments also emerge in conversational accounts, write-ups and in upgrade decisions on different computer models. The risk of uncritical external dependency is often a consequence, as the fish is "*swallowed with its bones*", in this philosophy of computing by the Frankfurt School of Technology Studies (STS).

4.2 Instrumentalism

Instrumentalists also attach a neutral status to technology, with no capacity to shape the ends beyond the purpose for which it was made. It has no implications on the user since it is just how you use it that matters (Czerniewicz, Ravjee, and Mlitwa, 2005). No ethical considerations, no health impaction, no unwarranted intrusions. Technology is merely an instrument to further your goals (Table 1), depending on how you use it. Whilst this critique could seem trivial when relegated to small personal computers, it remains an important consideration for decisions on big scale projects.

4.3 Substantivism

Substantivism sees technology as autonomous, but value laden – and never neutral, where both the means and ends linked in a system (Feenberg (2003). Meaning that technology influences usage processes and change. It is also influenced by those processes. External values are embedded in the dynamics of its design. How it is designed (means) will certainly shape the end goal of its use. It can also shape one's working patterns to suit the technology front and backend design (as means – and -ends are linked in a system). Since it is autonomous, it can do things guided by the programme that must not be interfered with. Whilst an element of influence on the user is implied, so is a synergy between the design. In a choice between open-source software systems and applications, both the determinists and substantivist would see no need to pursue design controls. They would most likely go the proprietary software route.

4.4 The Critical Theoretical Approach

Here, technology is human controlled, and value laden (Feenberg, 2003). In this case technology is used as a tool to further our goals. Value Laden-ness is a valid cause for caution, as technology carries with it the context of its design, the language and cultural connotations of its location, to influence its destinations. Hence, critical theorists would be wary of uncritical "technology praise-singing", without first interrogating potentially embedded connotations that could emerge out of its deployments and uses.

Critical theorists would appreciate advantages of efficiency that technology offers, but question embedded access issues. Hidden profit maximizing intentions of ICT manufacturing companies vs. relevance to the needs of the user have since been raised; with sensitivity to the long-term implications of proprietary software licenses on unsuspecting destinations. Computers and Internet connectivity is argued to enhance synchronous and asynchronous engagements. Taken at face value without contextual considerations, could inform development strategies beyond the borders of recipient countries, with unanticipated impacts.

Radical critical thought holds that technology is pre-shaped by the biased technocratic agents that presided over its creation. Hence, progressive technological review under the influence of more humane social forces is required (Marcuse, 1964). Technology is not autonomous, but carries the agency of its design, with language, culture and ideological connotations embedded in its shape, programmes and applications (Pickering, 1992). It draws on social constructivism for an alternative to technological determinism, recommending engagement with device and application designs to embrace user interests in the design. The role of interpretation in the development and acquisition of technologies is put forward, where providers should be engaging users, and users evaluating technological solutions that are dumped on them.

As an ideal approach, the critical perspective (Feenberg, 1999) is adopted to conceptualize technology as part of the human-machine symmetrical network of persons and things (Latour, 1992). Congruent with the critique of the "context-free" rationality in the early Frankfurt School of Technology Studies (Horkheimer, 1995), the ANT perspective highlights a potential bias of technology, and the apparent implications that technical networks could have on identities and worlds (Feenberg 2014). The critical theory questions the "rational society" basis to technological developments, acquisitions and uses as not always the "one best way". It should be contingent on values and interests. Eventually, through innovation, appropriate technology innovations should prevail, not due to absolute technical superiority but to contingent historical developments understood by embracing the actors' struggles for control of the design process.

A concept of technical citizenship is then introduced, with the premise that individuality cannot be conceived in complete independence of other people and things. Instead, an actor network approach to value interests of individual users, for whom developments are being made - should be embraced. The reflective capacities of users should always be embraced in designs, developments, or even in major entity deployments. Hence, the critical perspective is embraced in conceptualizing the "technology connectivity" project for the success of AfCTA in this lecture.

5. Determinant Terminology

- ✓ 4IR Readiness
- ✓ Networked Society
- ✓ Broadband
- ✓ Knowledge Economy
- ✓ Connectivity Essentials (CEs)
- ✓ AfCTA
- ✓ Critical Theory of Technology
- ✓ Activity Theory
- ✓ Activity and Development (ActAD) Framework

5.1 4th Industrial Revolution (4IR)

The 4IR is an intangible Construct – to define an era (rather than an item) of economic, technological, and social engagement. It embraces the fusion of the digital, biological, and physical worlds – marked by a growing utilization of new technologies. The list of characterising technologies include the Internet of Things (IoT), Robotics, Artificial Intelligence (AI), Cloud Computing (CC), 3D printing, and advanced Wireless Technologies, among others (Signe, 2020). Networked technological capabilities is the ethos, thereby relegating rigid conventional economic means and processes of innovation, engagement and exchange, into obsolescence. As an aggressive evolution, the 4IR have re-defined the economic landscape from the industrial economy (as we knew it), into the new "Knowledge Economy" where only the "Networked Society" (Castells, 2004) can thrive.

Needless to say, each member country to the AU should ready its technology infrastructural landscape, and "Network" its "Society" with technology infrastructure, ICT Connectivity, Innovation capacity, skills and cost-minimising frameworks to capacitate the AfCTA competitive ideals over the unforgiving 4IR climate (Mlitwa, 2011). From the critical theory perspective however, an approach to delegate infrastructural deployment to individual countries allows local needs consciousness into deployments, development and acquisition processes. Even at national level, administrators, policy makers and development agencies should be wary of technology determinist tendencies to local interventions. Indeed, a synergy between 4IR readiness and local contexts can guide contributions of AfCTA members countries towards relevant infrastructural enrolment choices, with minimal long-term risks to relevance in this continental infrastructure development drive.

5.2 The Networked Society

A Network Society is a derivative of the Information Society, coined to emphasize information technology connectedness that defines it. It epitomizes informationalism. An "information technology connectivity" descriptor – gives a new "information" and "knowledge" economy, a structural emphasis – where almost all productive human activities are facilitated by globally linked technology networks, tools and related systems with Big-Data (and analytics) as core. To this society, Castells (2004) argues that "the production of a self-programmable, information literate workers become an important factor of the global informational economy. Three points emerging from this short background, are that:

- ✓ Innovative information exchanges define a competitive edge in the global informational economy
- ✓ Information technology networks (with related tools, processes and systems) are core to effective engagements in this global economic domain.
- ✓ Obviously, internal economic capacity to generate knowledge and process information (using high powered, networked, micro-electronics technologies) – allows entities, nations, regions or continents – a competitive advantage in the newly defined global economy. The *Silicon Valley as well as the emerging South-East Asian Markets (such as Singapore), among others, are cited as notable examples (Castells, 2004)*.

Along this perspective, immediate development stakeholders such as the United Nations highlight similar essential considerations to development efforts:

- ✓ Creation of technology (measured in patents and receipt of royalties from abroad, per capita)
- ✓ Diffusion of recent innovations, i.e. internet and other products as a share of exports, and
- ✓ Diffusion of old innovations such as electricity, phones and human technical skills (innovators)

From a socio-technical perspective, a "Networked Society" is a personification of the 4th Industrial Revolution (4IR). It captures the defining characteristics of the 4IR citizenry. Capabilities to innovate, interact with, and manoeuvre around

the 4IR defining technologies, becomes personal traits of network society citizenry. From the critical theory of technology however, caution is flagged on recruits, never to lose sight of the contexts in their 4IR transitions. Within the same critical outlook, the defining phenomena as the Internet of Things (IOT), emerge strongly in this "*connectivity essentials*" discourse.

5.3 Internet of things

Stated simply, Internet of Things (IoT) is an evolving, infinite network of devices capable of acquiring data through electronic means, including sensor capabilities, and to share such information between them via internet and other protocols, mostly, wirelessly (Srinivathan, et al., 2019). The IoT merges digital and physical realities for smarter and timely solutions that would be necessary to keep AfCTA initiatives at a competitive edge – with power, flexibility and speed as essential characteristics. It is embodied in new devices and applications – that define smart homes and cities, cloud computing, remote medical services, augmented reality, and machine-to-machine communications for industry automation (van Stam & van Greunen, 2014).

Fibre optics and 5G mobile broadband technologies connects people, applications, systems and larger data packets in smart networks - across a wider array of devices, much faster.

IoT capabilities (in its various segments) are arguably presented as a matter of competitive necessity – from a deterministic perspective. At the Internet of Everything (**IoE**) level, continental readiness at the level of (1) people capabilities (skill to develop, manage or innovate devices and applications), (2) processes, and readiness in terms of the actual (3) data facilitation tools, i.e. for analytics, storage, and sharing of information – extends beyond a matter of relevance, into a need and capacitation pre-requisites (Motlagh, et al, 2020). Capabilities on the Internet of Nano Things (IoN) talks of a continuous cycle of innovations – where nano-scale devices are sensor enabled to collect, process and exchange Nano-data for further innovative solutions would further strengthen a competitive advantage at the AU individual country level. Effective collaboration on mission-critical operations can be further enhanced with fluency on the Internet of Mission-Critical Things (IoMCT) and the Internet of Mobile Things (IoMT), for AfCTA's effective integration into the Networked informational economy of the 4IR age (Anttiroiko, 2015; Castells, 2004).

Discussion on the "Networked Society" and the IoT highlights the viability of (i) Information and Communication Technology (ICT) infrastructure, (ii) tools, systems and processes, together with (ii) facilitating frameworks, and (iv) innovative skills sets as the (v) Connectivity Essentials – to empower not only the AfCTA initiative, but all 15 of its AU Agenda 2063 inter-dependent Flagship projects.

Sustainability considerations should inform development endeavours towards these ends. Otherwise, the continent could risks being trapped into externally controlled, exorbitant, permanent maintenance and licensing agreements – should it effect its ICT connectivity infrastructure, uncritically. Looking at the AfCTA potential, its ICT connectivity status deserves an exploration.

6. Connectivity Development Status in Africa

The EU2063 development project under Flagship 10: Pan African e-Network (by the AU Infrastructure and Energy commission) highlights the "**Intra-Africa Connectivity – and Connecting Africa to the rest of the World development,** as an urgent project (Abou – Zaid, 2021).**.** Behind this **goal is an objective to** develop "Transformative e-Applications & Services in Africa. Arguably, these endeavours will contribute immensely towards establishing a competitive, 4IR ready "e-Society" in Africa. Development of an intra-Africa (i) Broadband Terrestrial Infrastructure, (ii) Cyber Security, and to advance an (iii) information revolution as a basis for service delivery (*with the bio-technology, and nano-technology industries, ranking high in the order of priority). It is implemented under the AU Programme for Infrastructure Development in Africa (PIDA 1) ICT priority action plan, with the first phase completed in 2021* (Abou – Zaid, 2021).

6.1 PIDA Infrastructure Development Project: The ICT Priority Action Plan

PIDA is the infrastructure development instrument. It is divided into 10 member-country implementation projects, under the as championed by selected country presidents in the Infrastructure Champion Initiative (PICI). Out of the 10 projects, only 2 are relevant for this reflection:

- ✓ PICI Project 1 - Optic Fibre Link between Alegria and Nigeria, via Niger (as Championed by Algeria:), and
- ✓ PICI Project 8 - ICT Broadband and Optic Fibre Projects Linking Neighbouring States. The infrastructure development linking Rwanda with neighbouring States in East Africa (as Championed by Rwanda).

Developments to connect other parts of the continent are to be embraced in PIDA 2, and beyond.

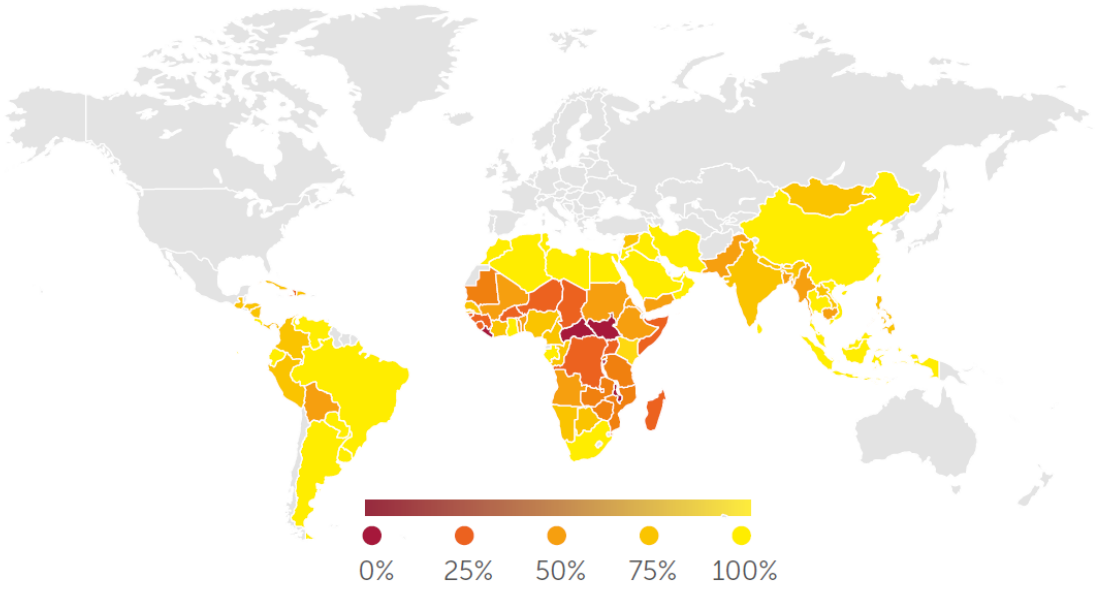
The AU Development Agency (AUDA – NEPAD), also seeks to increase access to the internet, through its technology and digitisation project, albeit, ranked below 3% in the order of development prioritisation, compared to industrialisation at 52%, Education at 52%, and Health at 74%.

In a 2021 progress reporting cycle, the 2 projects had been completed, pending the launch and rollout. The first 2 projects reflects the first basis to effecting the connectivity projects in west and East Africa.

6.2 The ICT Connectivity Project in the Continent

Access to wider networks is a gateway to more information, and ultimately opportunities. A reference to the IoT highlights the essence of the basic universal access, and a speedy interconnectedness between multiple information sensing devices. Numerically, growth of interconnected devices over the internet is projected to exceed 50 billion by 2025 (ITU, 2021), due mostly, to the evolution in 4IR technologies, including satellite, fibre optics, as well as the fourth and fifth generation (4G and 5G) mobile capabilities. From the AfCTA perspective, Africa should be part of the inter-connections at this growing scale. For, this will allow expansion of people, data, information and business transactions to wider destinations and audiences.

Starting with the electricity connectivity status in Figure 1, the status of infrastructure development in Africa is reflected in the next section.



Source: IEA https://www.iea.org/sdg/

Figure 1: Population with Access to Electricity

As South Africans would know, the statistical meaning of 100% access does not always translate to 100% quality and availability. Electricity connectivity in terms of infrastructure is full in the South, and in North Africa. The situation remains minimal in most countries of the continent.

Obviously, its redress should precede (if not parallel) the broadband infrastructure connectivity efforts if positive connectivity spin-offs are to be realized in ambitious undertakings such as AfCTA.

6.3 Broadband Infrastructure in Africa

This section reports on the status of broadband access in the continent, per country, in Figures 2, 3, 4 and 5.

Figure 2 reflects the status of Fixed ICT infrastructure connectivity status, in its various levels development. Fibre optic cables, which embodies the epitome data transmission volume and speed, have grown beyond a mere west-cost Optic-Fibre pipeline in 2009, to fully surround the continent. A sneak preview to the North and East (Asian) countries on the map however, reflects even thicker Fibre Optic line/s (which is quantity and volume) in the Middle East, Europe and parts of Asia.

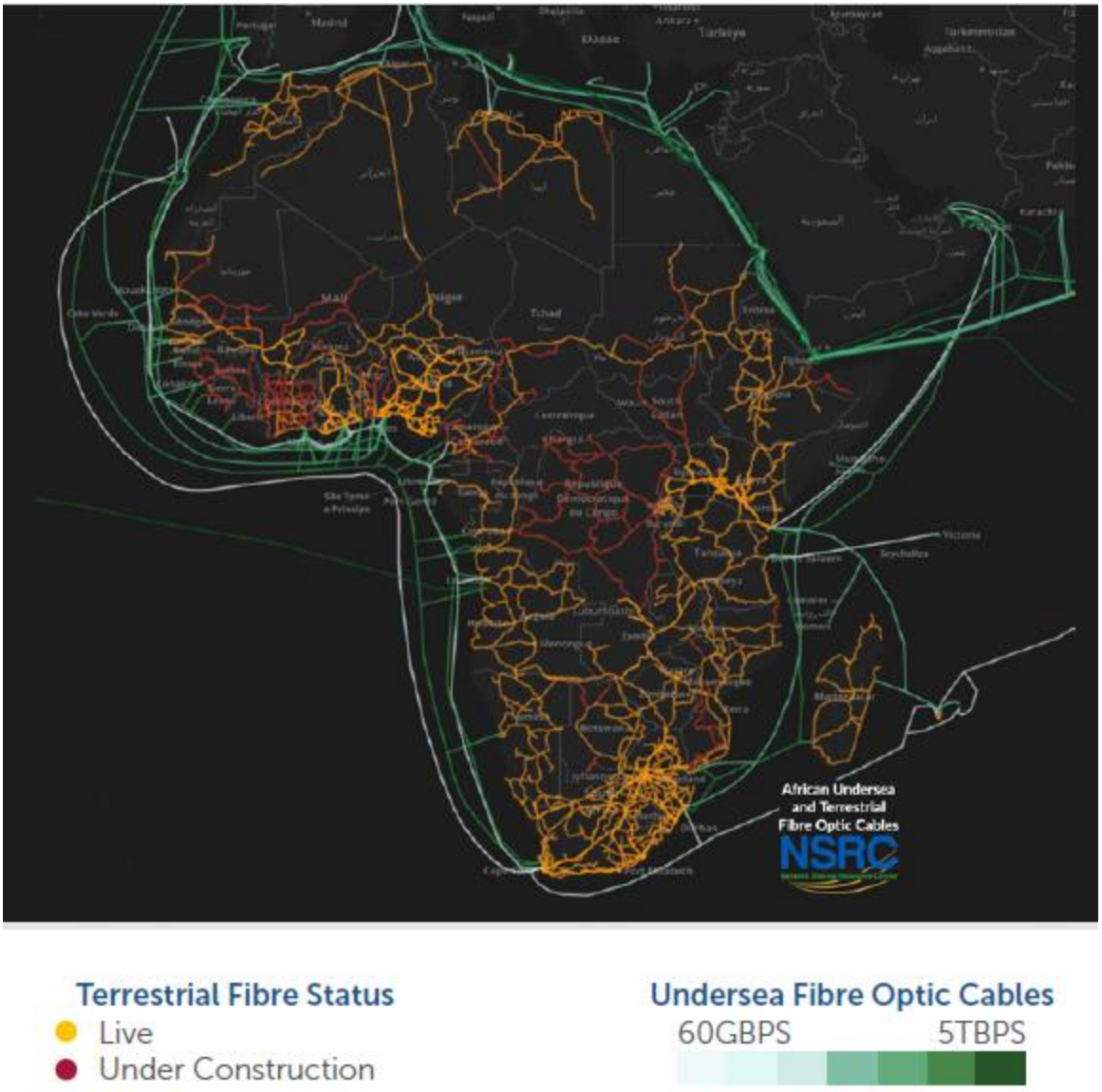


Figure 2: Status of Fibre Cables in Africa

One would appreciate however, that beyond the lines that are live / operational (Yellow), red lines reflect a significant amount of terrestrial network construction work among the landlocked countries in this continent.

Obviously, seeing the status of infrastructure without reference to its use, does not help much. In Figure 3 we link live networks to areas per population density.

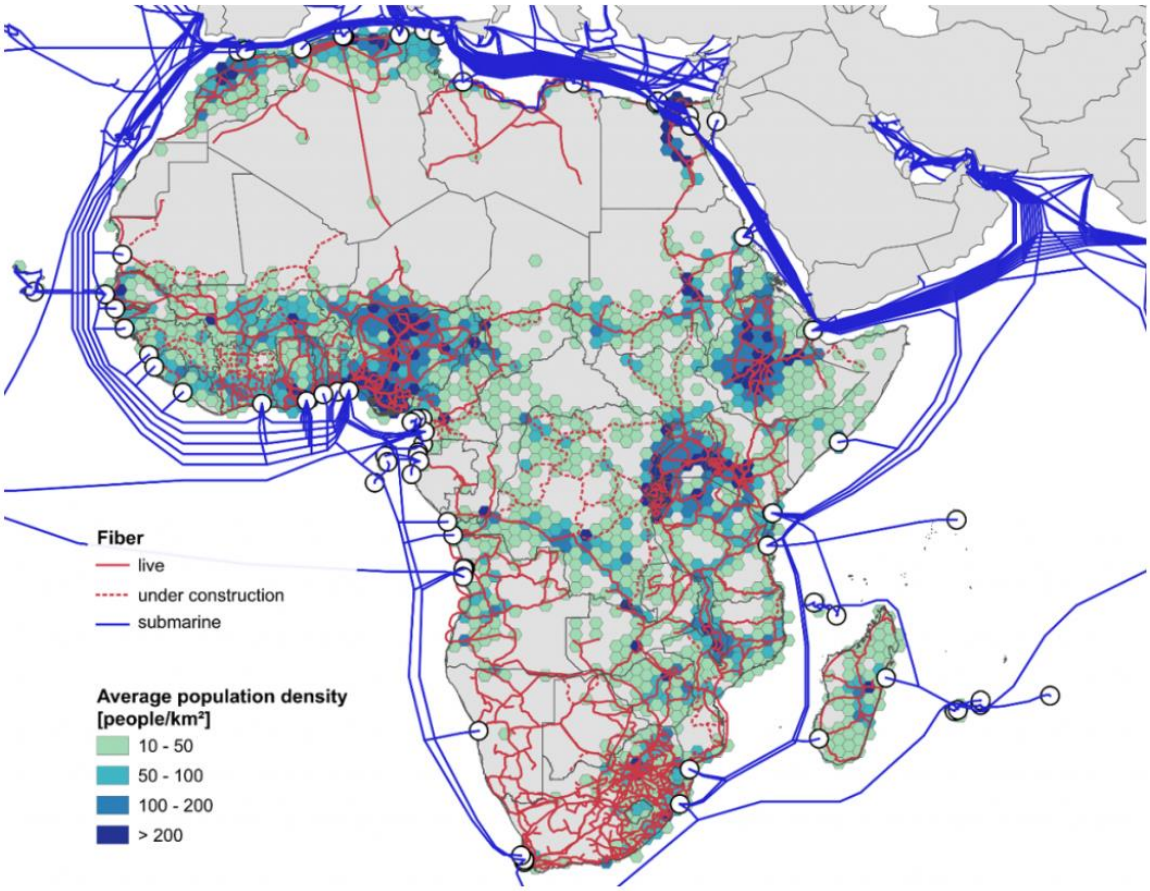


Figure 3: Distribution of Broadband in Africa (ITU, 2019)

Obviously, Optic Fibre infrastructure should be exploited, and it is not many countries that are connecting to the submarine backbone.

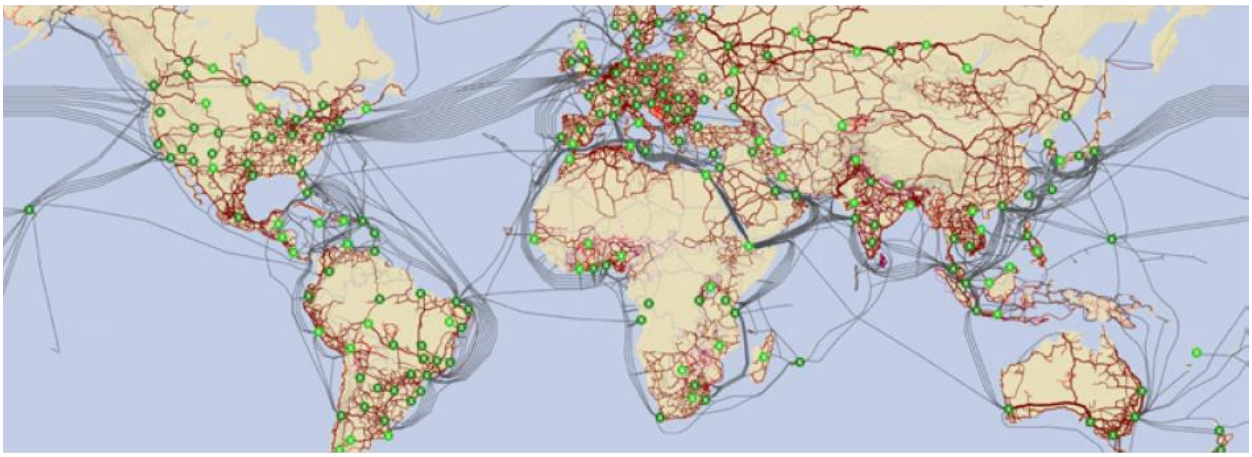


Figure 4: Interactive Transmission Map - Optical Fibers, Microwave, Satellite Earth Stations (Source: ITU-UNESCO, 2019)

Data in Figure 4 (the transmission map) maps out (a) transmission network length in KMs; (b) Node locations, (c) Type of terrestrial transmission network, (d) network capacity (in bit rate), (e) optical fibers within a cable, (f) operational status of transmission network indicators, (g) percentage of population within the measured area, and finally (h) percentage of areas within reach of a transmission. Data is validated by network operators through ITU regional offices.

The broadband development project clearly reflects notable growth in the continent. However, data in Figure 4 still shows passivity in the continent, relative to interactive engagements in Western Europe, the Americas and Asia. Interactive connectivity in Figure 4 however, reflects an upward trajectory – mainly on mobile rather than on the fixed, satellite and terrestrial broadband.

Productive activity generally, should probably evolve as the infrastructure development, and usage cost mature. Starting with 4G Mobile broadband penetration status in the continent (Figure 5), a full status of broadband penetration is presented in this section.

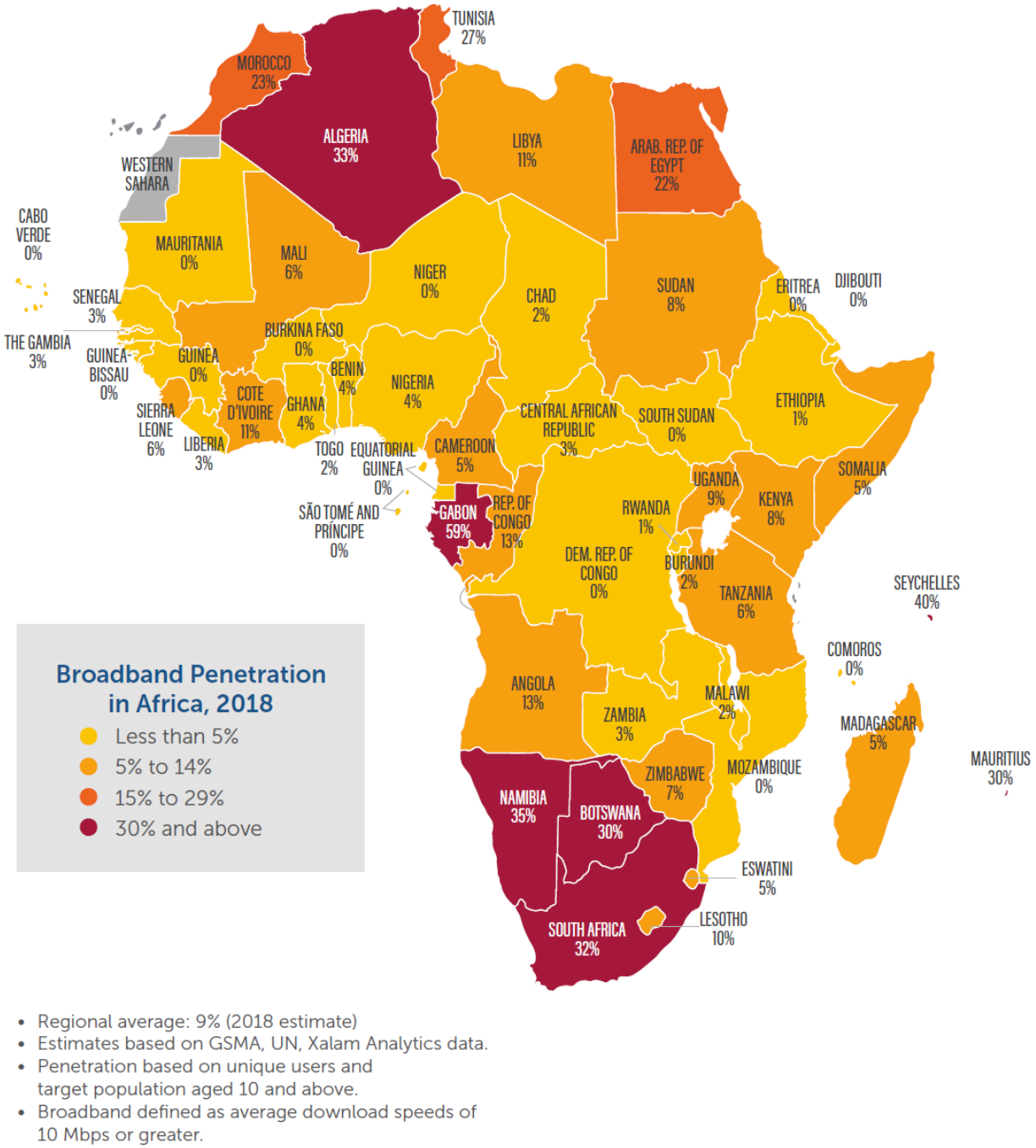
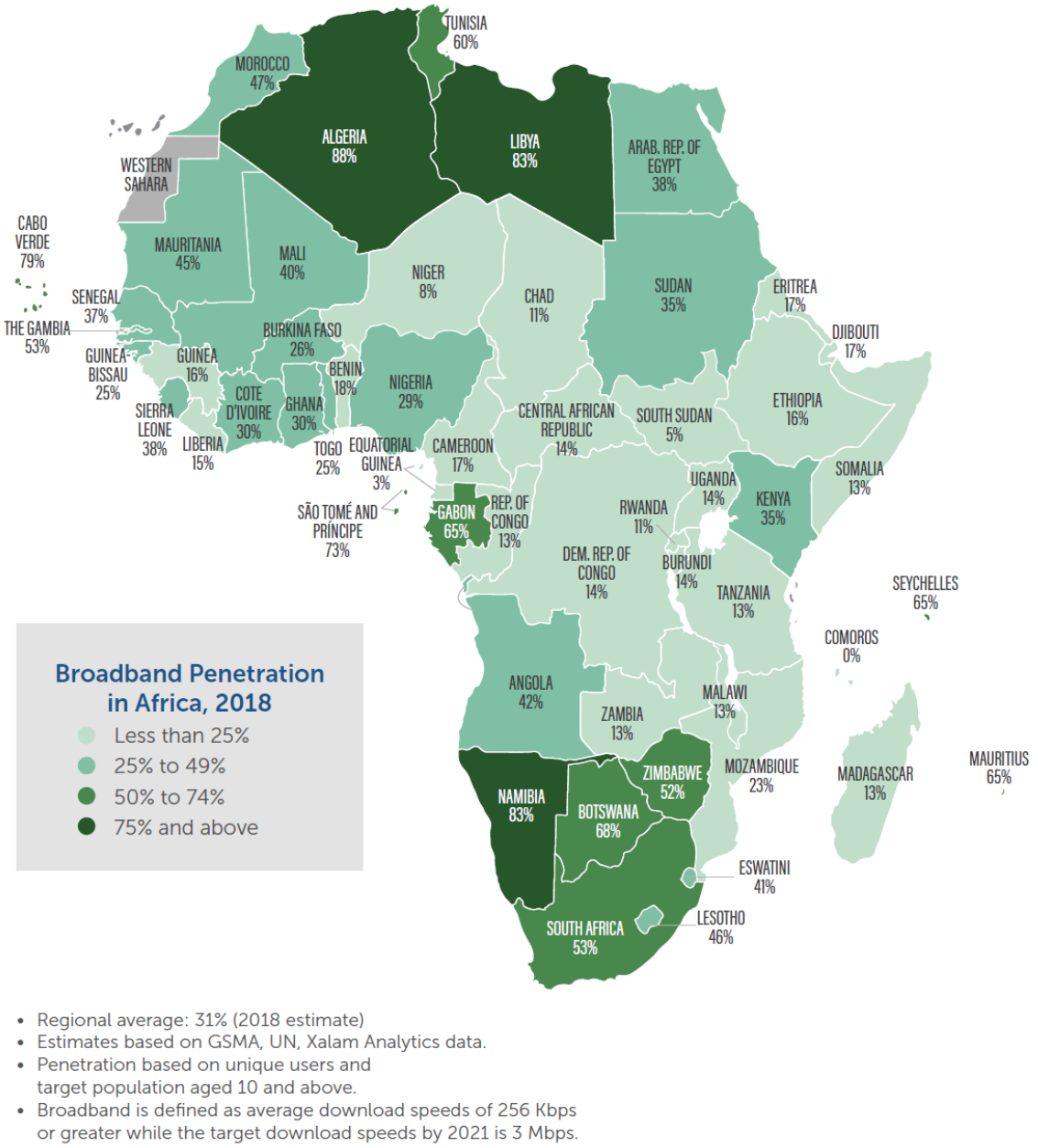


Figure 5: 4G Mobile Broadband Penetration, by Country
Source: ITU - UNESCO, 2019

The Status of Total Broadband penetration is depicted in Figure 6.



- Regional average: 31% (2018 estimate)
- Estimates based on GSMA, UN, Xalam Analytics data.
- Penetration based on unique users and target population aged 10 and above.
- Broadband is defined as average download speeds of 256 Kbps or greater while the target download speeds by 2021 is 3 Mbps.

Figure 6: Total Broadband Penetration, by Country
Source: ITU-UNESCO, 2019

Whilst the ideal penetration status should be 100%, only 3 countries are coming close – with 83% in (i) Libya and (ii) Namibia, and 88% in Algeria. The following Latin phrase: "Aluta Continua", perfectly applies to the rest of the countries in their endeavours to catch-up with the 3 "Joneses – perhaps through mobility enhancements?

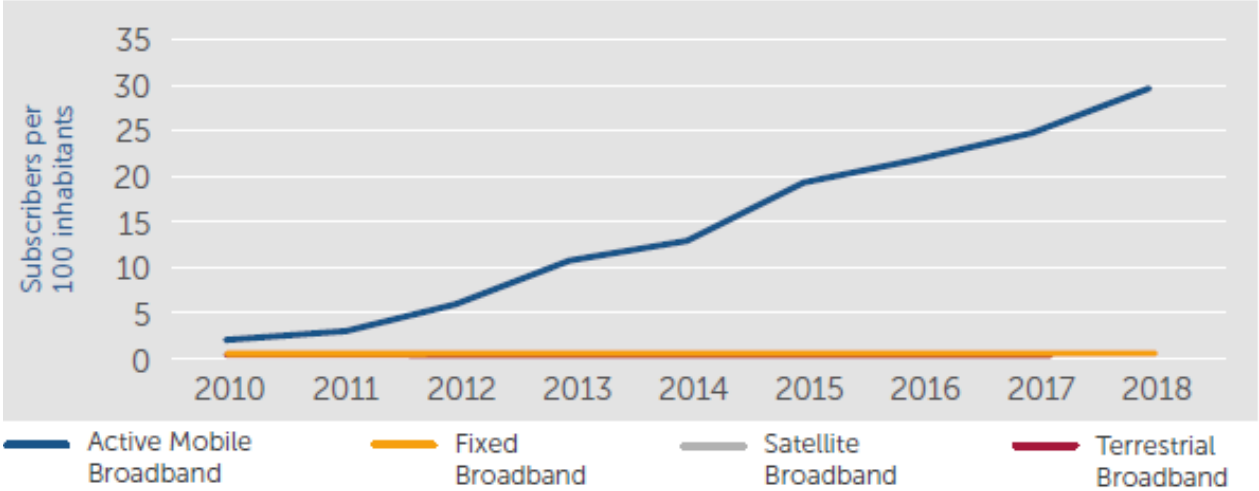


Figure 7: Broadband penetration in African countries, by technology type
Source: ITU, 2019

Obviously, penetration statistics should also be understood in terms of the actual usage. The status of Internet usage in the continent, is outlined in the following section.

6.4 Internet Access and use

The "universal access" can be such is a catchy phrase with very noble connotations when used within realistic endeavours. Otherwise, it can easily give a mockery "swore-word" feel when abused.

With the exception of (i) Botswana, (ii) Cabo Verde, (iii) Gambia, (iv) Mauritius, (v) Seychelles and (vi) South Africa, most Sub-Saharan Africa countries have internet usage lower than 30% (individuals) and 20% or less for households, in Figure 6 (ITU, 2019).

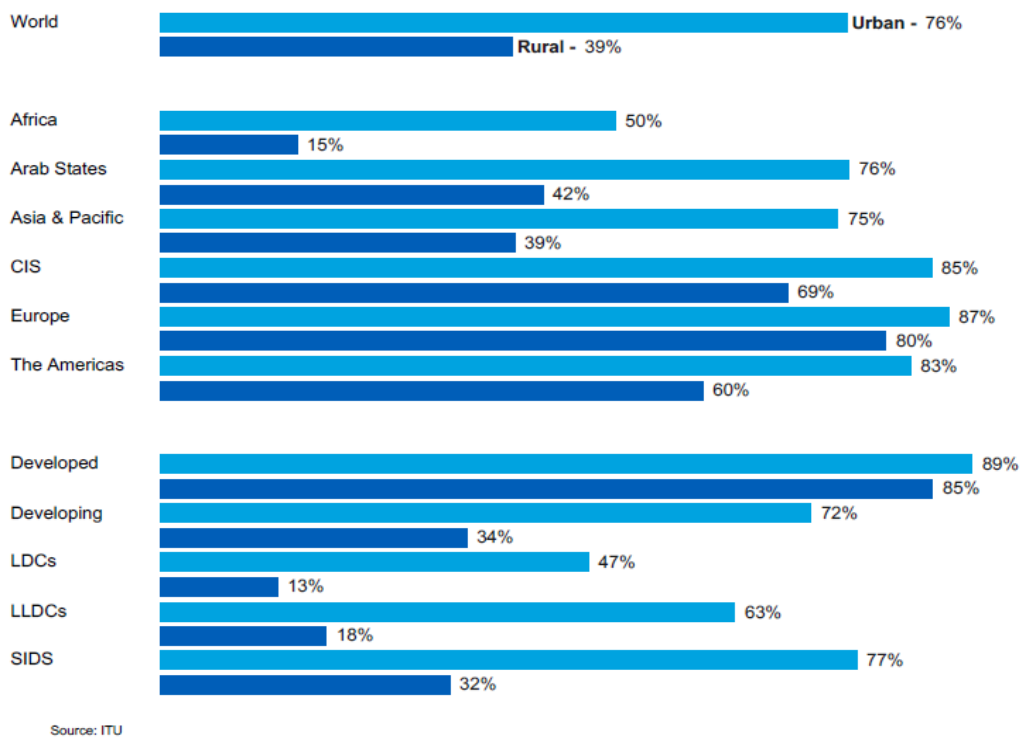


Figure 8: Percentage of Internet use in rural and urban locations in 2020

Beyond the urban-rural divide, are further discrepancies in terms of access between countries in the continent (Figure 9).

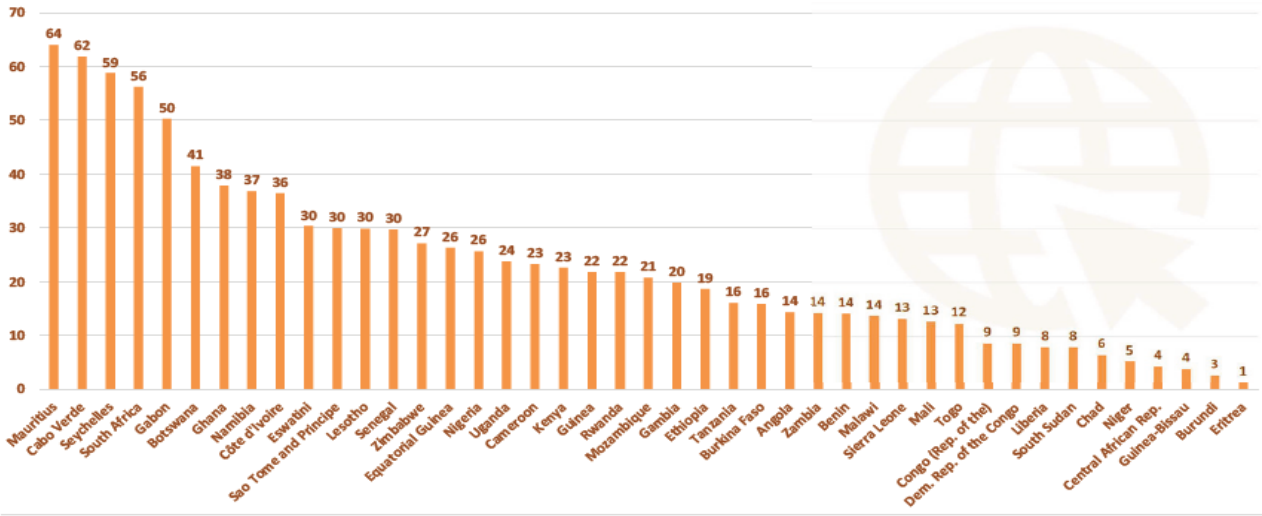


Figure 9: Rate of individuals' internet access and use in Sub-Saharan Africa by percentage

Despite the increasing amount of internet users, proliferation of data-intensive applications and cloud-based services, Africa is lagging far behind compared to other regions with regards to international bandwidth at the aggregate and

individual levels. For instance, data from 2021 showed that the average internet use in the African region had a bandwidth of 34kbit/s compared to the 296kbits/s of a global internet user.

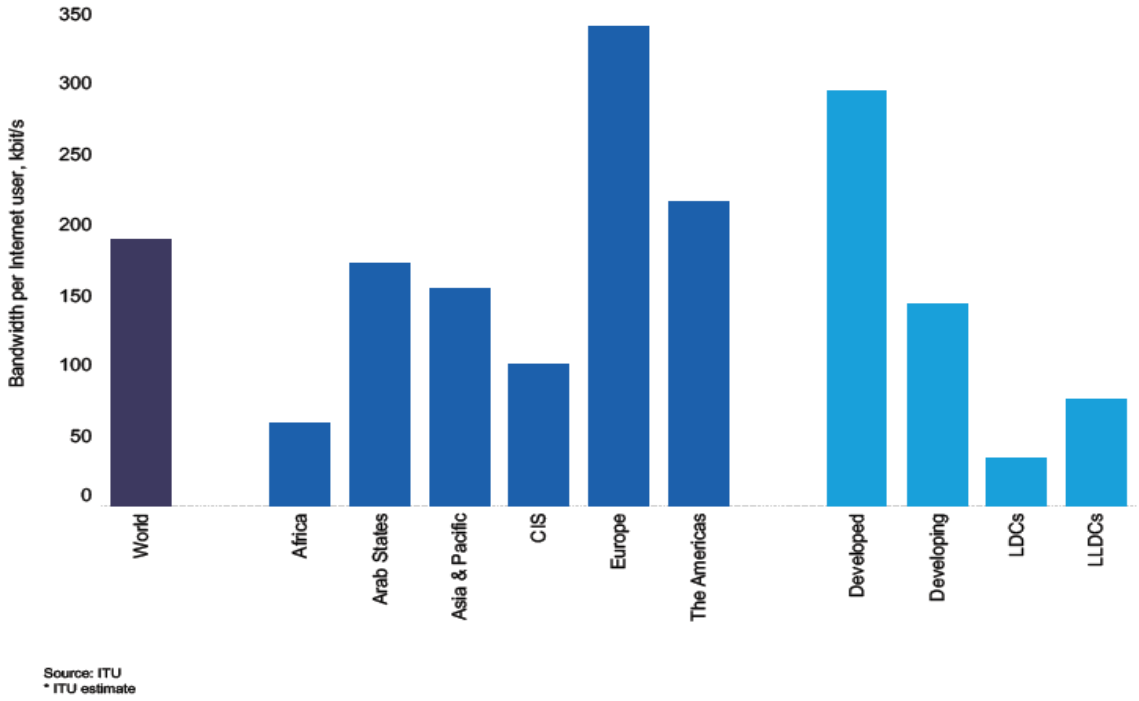


Figure 10: International bandwidth per internet user in 2021

6.5 Affordability

Affordability, in the sense of expenses connectivity gadgets and mobile data often inhibit broadband access and use in low income countries. Competitive prices of broadband service operators, and subscriber usage among global or local service providers, also escalate costs (ITU, 2019). Africa has the highest fixed-broadband costs in relation to the percentage of gross national income per capita (GNI p.c.).

On average, people in Africa are paying over 2% of their incomes for mobile broadband at a significantly costlier rates by comparison to high income economies, which could limit internet usage. Access costs on mobile and fixed broadband is presented in Figure 11.

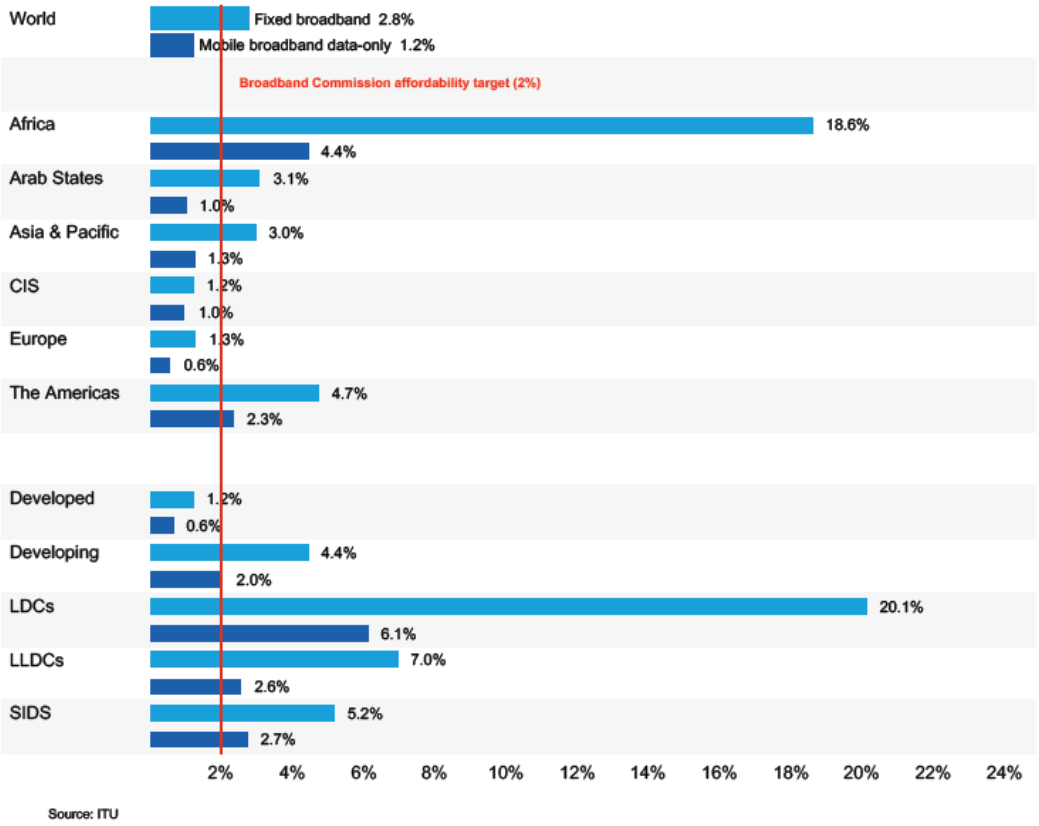


Figure 11: Fixed-broadband and mobile data prices as percentage of GNI p.c. in 2020

The status of ICT infrastructure connectivity is unfolding at a promising rate. However, the backlog is massive, many countries still without the minimum access. Electricity is still not accessible in many parts of the continent. The cost of access also remains a prohibitive factor to the universal access ideal.

7. The Activity Theory

The Activity Theory (Miettinen, 1997; Engeström, 1987; Leont'ev, 1978; Vygotsky, 1978) is adapted to channel discussions and recommendations. The theory views human mediated projects as "purpose driven", "activity based", and context-situated phenomena (Leont'ev, 1978). Such projects are further viewed as "collective work-activities" – where an activity consists of widely accepted, rules-based, deliberate and collective work by various actors (subjects), in pursuit of a common purpose (object), using tools (artefacts or instruments) in respective roles - to carry out actions towards a common goal (outcome). Because of multiple actors (subjects) on different activities, where interest to the pursued objective (object) in the same work-activity is shared by many (i.e. individuals, public groups, governments, regions, development entities, etc), work activity is described as situation-dependant, highly mutable, prone to value conflicts, and therefore, complex (Bødker, et al, 2004). The AT builds on the work of Engeström's, (1987) Developmental Work Research (DWR) model to propose a fitting work-activity analytical framework – with emphasis

on the “activity system” (Kuuti, 1991) or a holistic “systemic entity” in terms of linkages between the purpose (object), stakeholders (subject), process (transformation), enabling artefacts (mediators), and the outcome (Korpela, et al, 2004; Engeström, 1990). Descriptive accounts, make sense of practical developments, and operational sense to workers and users must be enabled. The Activity Analysis and Development (ActAD) Model is proposed to analyse the AU 2063 Pan Africa e-Network: Infrastructure and Energy project, from the AfCTA capacitation perspective (Figure 12).

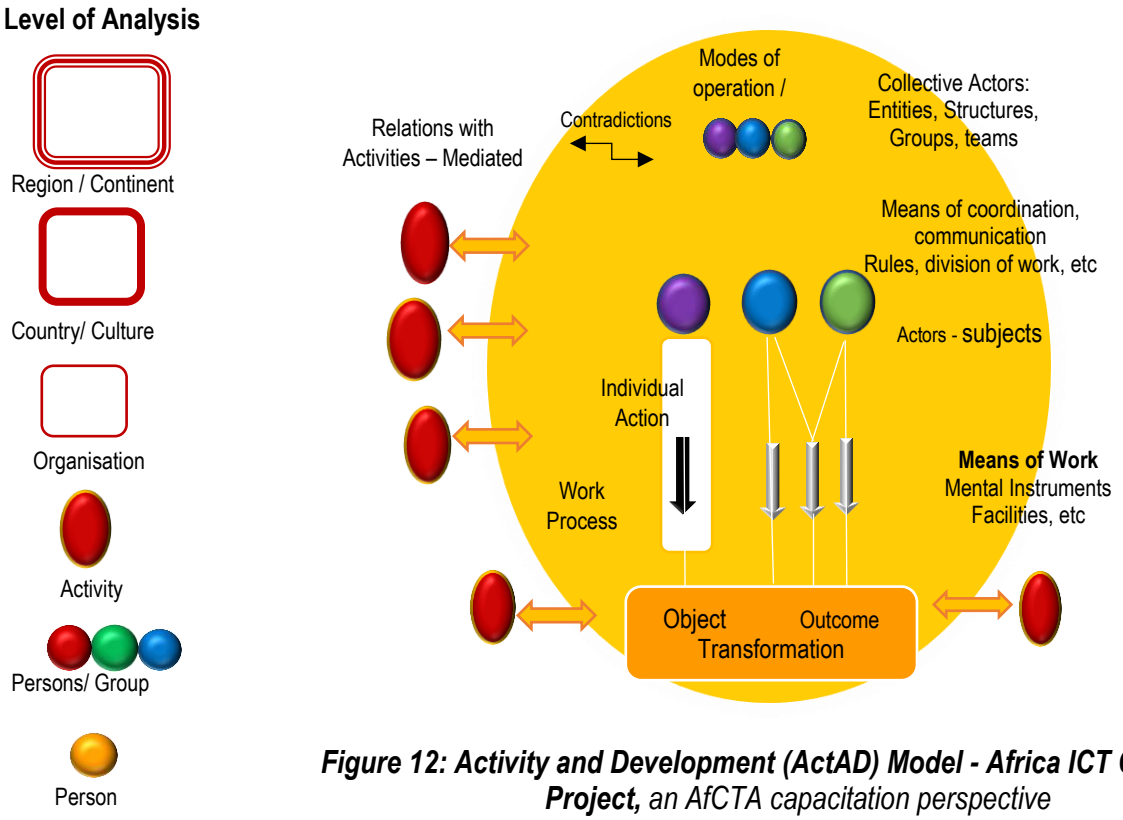


Figure 12: Activity and Development (ActAD) Model - Africa ICT Connectivity Project, *an AfCTA capacitation perspective*

The model is presented as a conceptual outline to the Analytical framework in Figure 13. The analytical framework then, depicts the project as a Work-Activity System with multi-stakeholder intercedences in pursuit of a common goal - embedded in its conception, terminology and focus. Thus, a work activity framework can be drawn to map out an activity system for a multi-stakeholder, AfCTA ICT connectivity project in Figure 13. Applied diligently, the framework offers a holistic tool for planning, implementing or even testing the efficacy of an ICT infrastructure development undertaking in massive projects such as the AfCTA ICT connectivity initiative.

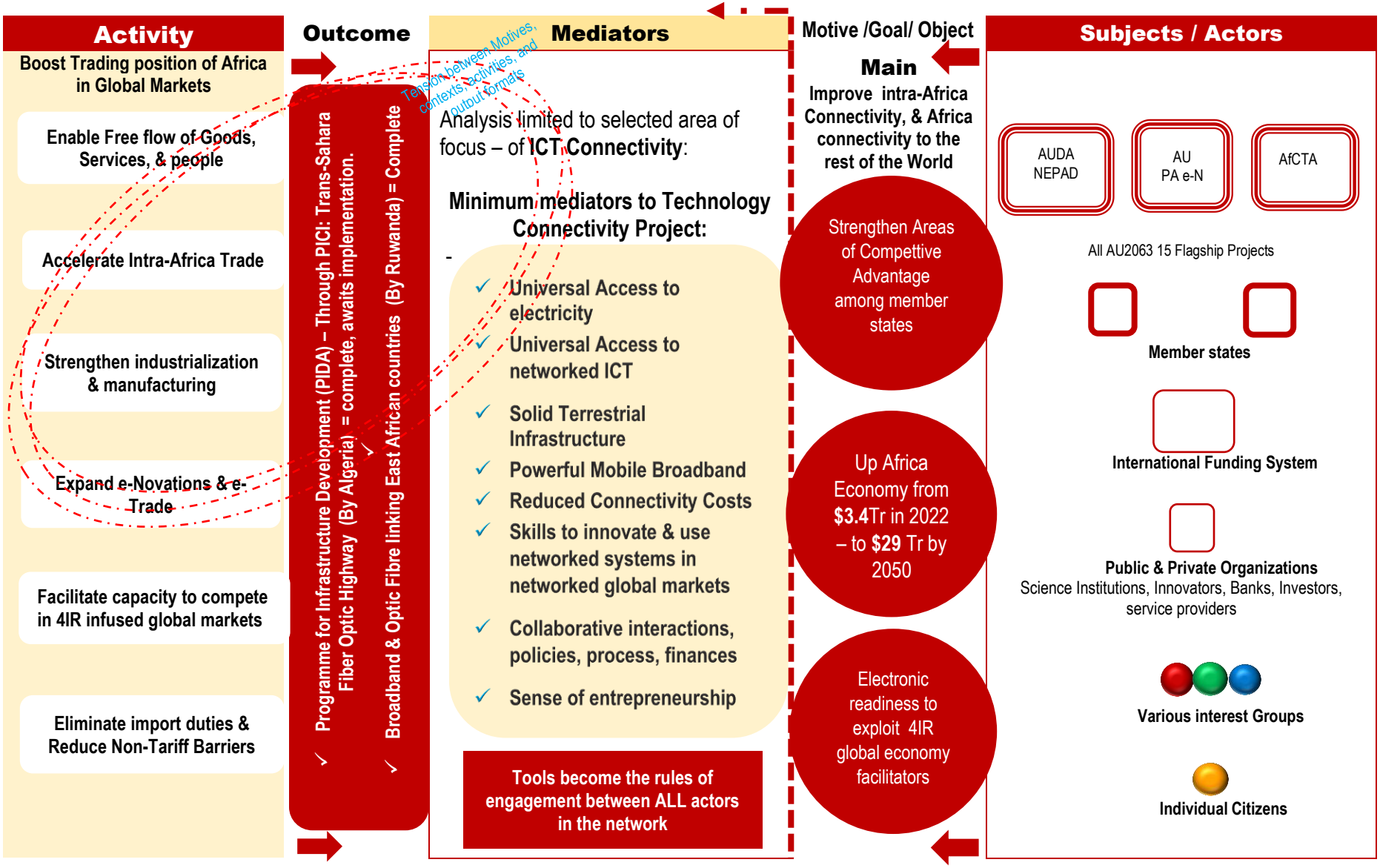


Figure 13: Africa ICT Connectivity Work Activity System - *An AfCTA Capacitation perspective*

In Figure 13, the Africa ICT Connectivity Work Activity Framework offers delineated ICT capacitation process to the complex AfCTA project – from the Activity Theory (AT) perspective. Describing the environment as a work-activity system, it opens with the basis of the project, the (i) the main goal/s or object, which helps to define an appropriation of (ii) multiple of stakeholders, the subjects (AT) or actors (ANT), (iii) Activities in their diversity, (iv) the mediating factors (positive or negative), (v) underlying tensions (from complexity), (vi) tools, and ultimately, (vii) the mediated outcomes.

The framework accurately defines the type of data, the research population, the sample, and the actual questions to be addressed. The units of analysis thus, were processes undertaken by the AU 2063 Flagship Projects 3 (AfCTA) and 10 (Pan African e-Network) initiatives to define and implement Fixed and Mobile broadband as well as sustainable universal access. The following section interrogates infrastructural implementation data from the AU 2063 intra-flagship project structures that make up the ICT Infrastructure Connectivity project depicted in Figure 13. It draws on data from the Pan African e-Network project to (i) describe instruments to" (Abou – Zaid, 2021). effect a "Transformative e-Applications & Services in Africa".

8. Conclusion

The significance of the AfCTA project – in the AU2063 agenda was recognized in this lecture. In particular, the drive to develop the continent into the largest economic block. The global economy however, is a competitive stage shaped by the innovative 4IR capabilities – hence the urgency of fit-for-purse ICT infrastructure deployments within (and across) the AU member countries if the AfCTA long-term competitive ideals are to be realised. An undertaking was thus, to reflect on the Africa continental ICT connectivity status and unfolding development initiatives.

The critical theory of technology was adapted to conceptualize technology development, acquisition, implementation, and usage undertakings. It views such endeavours as a network of symmetrically connected technical and human objects (actors) – all actively channelling pursuits towards ends realisation. Borrowing from the ANT, it suggests that all actors represent equally significant interests that should be collectively pursued, with equitable emphasis in project priority definitions. A risky trend according however, are *narrow Deterministic, substantive and Instrumentalist* disproportionate prioritisation one or more actor interests, at the expense of the "powerless others". Neglect of other actors negates the symmetric principle, whilst imposing biases of dominating actors within the network. The theory then, guards against asymmetry in work-activity systems - be it driven by profiteering motives, political influence, cultural or ideological manipulation, etc. For, biased (uncritical) technology infrastructure projects could yield information, digital and development divides – that could potentially negate AfCTA connectivity and, ultimately, competitiveness objectives.

Rather, all the actors (*not just isolated developers, traders, leaders, scholars, project funders, and or technology agents in the case of the AU2063 Pan Africa e-Network project*) - must be embraced, symmetrically in a deployment project, taking into account that:

- ✓ That major action-based initiatives, be it of infrastructural development or otherwise at organizational, national or transnational level, are not atypical of an actor-network formation
- ✓ Technology as a Value Laden construct, it is also an active actor (albeit, a technical one) – that cannot be superior but symmetrical to all other actors in an activity network
- ✓ Therefore, a technology infrastructure development initiative is an activity embedded process. It has goals, objectives and milestones – within contextual realities and constraints between and across symmetrical actors
- ✓ Complexity is described as omnipresent in an activity system, with objective-focused interactions between mediators and tools as a pre-requisite to successful realisation of pursued outcomes.

Notably, infrastructure development projects (*including ICT connectivity undertakings at any level*) should be cognisant of all symmetrical actor-interests (*an undertone bias towards users' interests emerges in the theory*). Evidently, limited access to electricity and the internet remains a decapacitating reality in larger parts of the continent. At 18.6% (fixed broadband) and 3.1% (mobile broadband) to the GNI.p.c. rate in Africa (vs 2.8% fixed and 1.2% mobile in developed countries), access costs to total broadband remain prohibitive to the universal access ideals.

Philosophical assumptions that often guide deployments have also been explored, yielding into a suggestion for a symmetry between interests of all stakeholders (including that of local users). The activity theory was drawn upon to propose the work-activity model as a holistic guide to activity-based deployments. The ActAD Model suggests that multi-stakeholder projects are complex and should be carefully structured to yield desired results. An ideal approach would be to present complex project implementations as a work-activity system – symmetrically catering for all interest. Not just the interest of multi-national corporations, international development organisations, the international development funding regime, and the national state elite at the expense of sustainable goals affected publics.

The work-activity framework was then developed as a tool to guide holistic deployments.
From this process, the following conclusions are highlighted:

8.1 Summary:

- ✓ AfCTA seeks to up continental competitiveness in the global networked economy ($3.4 Tr in 2022 – to $29 Tr in 2050);
- ✓ A capacitated "networked society" should emerge to enable this ideal. Hence, pursuits of the connectivity project

- ✓ Universal access to High-speed (Fiber Optic, and 5G) capabilities will enhance 4IR alignment and associated efficiencies.
- ✓ Connectivity efforts are evidently unfolding, with massive urban-rural, and trans-country divides, screaming loud for calculated efforts to fast-track the universal access prerogative.
- ✓ Critical Theory warns against asymmetrical conceptions that could misdirect deployment choices (in favor the international exploitative technocratic order) at the expense of local interests.
- ✓ If infrastructure deployments are externally founded, access costs might keep escalating to the point of defeating the universal access ideals (what are licensing arrangements? What are maintenance arrangements? What are Open access considerations?, and how about a "ultra-fast" (single modal) and costly vs "fast" (multi-modal) and modest priced broadband network deployment options?)
- ✓ Through the ActAD Framework, conceptualizing the technology connectivity project into a "Work-Activity System" – with symmetry of priorities in interests of all actors (including users) in deployment initiatives – is hereby recommended.

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