

Heterogeneous Networking Blueprint

Building Africa's Open, Resilient, Low-Cost Network Future

JOYCE MWANGAMA, UNIVERSITY OF CAPE TOWN, SOUTH
AFRICA



Funded by
the European Union

DIGITAfrica project has received funding from the EU Horizon Europe research and innovation Programme and Switzerland under Grant Agreement No. 101187966. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.





The Challenge: Africa's Network Reality

Why a purpose-built blueprint matters



Connectivity Gaps

600M+ people lack reliable internet; rural & peri-urban areas depend on fragmented 2G/3G infrastructure



Technology Fragmentation

No single technology fits all contexts — fibre, 4G/5G, satellite, mesh, and community radio all coexist



Power & Sustainability

Frequent power outages; solar-dependent sites; solutions must run without constant operator intervention



Skills Shortages

Limited local expertise to deploy & maintain complex infrastructure; blueprints must enable hands-on learning



What is a DIGITAfrica Blueprint?

A reusable, open-source deployment model for African research institutions

Blueprint

A modular, open-source reference architecture that any African research institution can adopt, adapt, and deploy — at their own pace, within their own resource constraints.

Blueprints are not products to buy. They are community-owned specifications for building sovereign, sustainable digital infrastructure.

Free • Open Source • Africa-Led

Composable

Built from reusable baseline services. Mix and match what your site needs.

Tiered

5 deployment tiers from a rural school (\$0.5k) to national 5G core (\$100k+).

Interoperable

Connects with SLICES-RI, NRENs, and other African partner sites

The Heterogeneous Networking Blueprint



Connecting diverse technologies into coherent, manageable infrastructure

A blueprint for deploying and managing networks that could span multiple technologies — 5G, WiFi, fibre, satellite, mesh — within a single, open, software-defined framework.

Technologies to be Supported

- 5G / LTE radio access
- WiFi (indoor & campus)
- Fibre backhaul
- Satellite (LEO/GEO) links
- Community mesh networks
- SDN-controlled switching

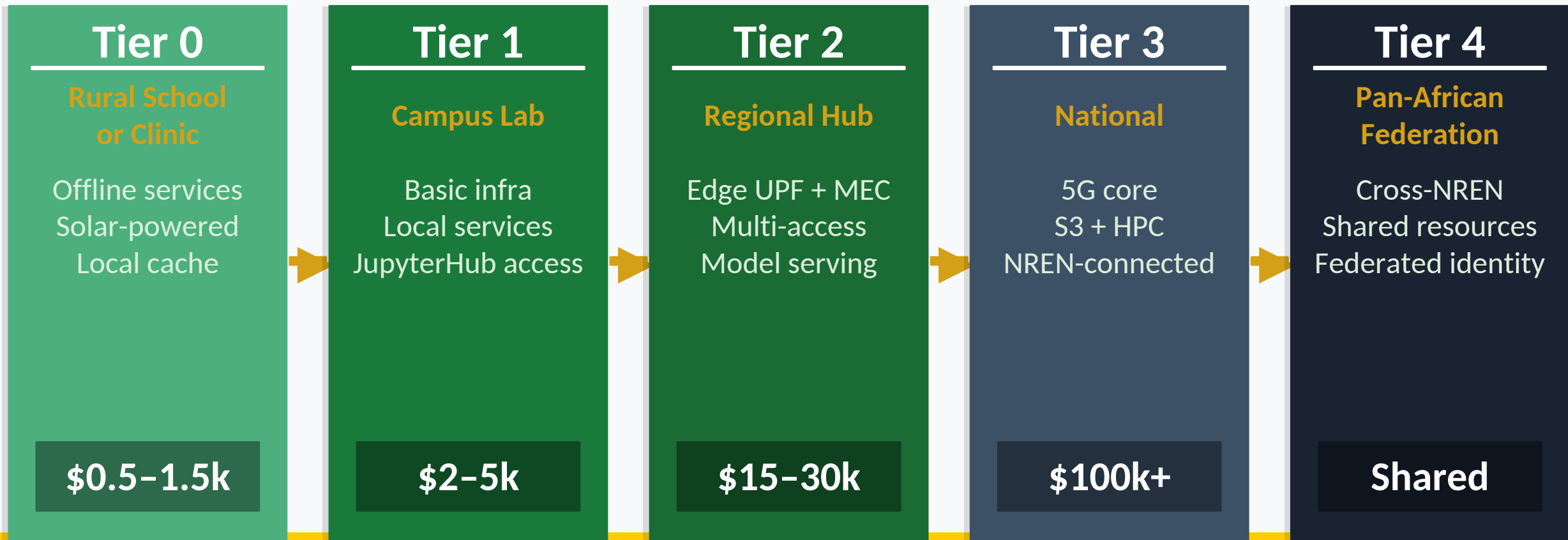
Why It Matters for Africa

- | | |
|--------------------|---|
| Sovereignty | No dependency on proprietary vendors or global cloud providers |
| Cost | Open-source stack; runs on commodity hardware and Raspberry Pi 4 |
| Resilience | Operates autonomously during power/connectivity outages |
| Education | Hands-on notebooks teach routing, 5G, VxLAN to students and researchers |

Progressive Deployment: From Rural School to Pan-African Federation



Start small. Grow as capacity allows.





What the Blueprint Enables

Real use cases across five DIGITAfrica countries

Z A South Africa

Campus testbed for 5G & OpenRAN research at UCT

S N Senegal

Multi-access edge lab at UCAD supporting AI and networking education

K E Kenya

Rural mesh or satellite hybrid for agricultural IoT connectivity

C M Cameroon

Low-cost campus network at Ngaoundéré enabling broadband access

T N Tunisia

NREN-connected research infrastructure at UMA integrating 5G testbed

These are not pilots; they are replicable deployments using the same open blueprint, available to any institution in Africa.

Under the Hood: Blueprint Architecture



Open-source, lightweight — runs on commodity hardware including Raspberry Pi 4

USER ACCESS LAYER

JupyterHub · Keycloak OIDC · SLICES-RI Federation

ORCHESTRATION LAYER

Kubernetes / K3s · Docker Compose · Anycast DNS

NETWORK SERVICES

IP Routing · VxLAN overlays · 5G Control Plane (OAI)

COMPUTE & STORAGE

NFS long-term · Host-based scratch · pip/docker cache

PHYSICAL INFRASTRUCTURE

Commodity x86 · Raspberry Pi 4 · USRP/srsRAN radios

Design Principles

- 100% open source — no licence fees
- Deployable on a single node or full cluster
- Federated identity across all partner sites
- Automated deployment via notebooks
- Runs offline — no cloud dependency

Current Status: Already Deployed and Running



Proof-of-concept validated at multiple partner sites

5

Partner Countries
Toward Active Deployments

100%

Kubernetes / K3s
Deployment Complete

100%

Local Access and SLICES-RI
Federation

Tier 0 + Tier 1

Validated in
Multiple Environments

Component	Status	Notes
Kubernetes / K3s cluster	✓ 100%	All services packaged for k3s deployment
JupyterHub notebook access	✓ 100%	Live at jupyter.theblueprintfactory.org & digitafricasn.ucad.sn
Keycloak OIDC user portal	✓ 100%	Local auth + SLICES-RI federation active
NFS & host-based storage	↻ 80%	Long-term sync across sites in progress
IP routing & VxLAN notebooks	✓ Done	Available on GitLab now
5G control plane notebooks	✓ Done	OAI-based; spectrum allocation TDD included
SSH / VPN remote access	⌚ 0%	Planned next phase



How to Get Involved

Three pathways — pick the one that matches your organisation's readiness



Early Adopter

Deploy Blueprint Tier 0 or Tier 1

- Access the open GitLab repository today
- Deploy on existing hardware — even a single laptop
- Join the DIGITAfrica community of practice
- Receive technical support from WP2 team



Research Partner

Co-develop & validate use cases

- Contribute a use case from your country context
- Co-author publications and deliverables
- Shape the roadmap for Tier 2/3 deployments



Strategic Partner

Champion, or mandate adoption

- Support national blueprint deployment programmes
- Integrate blueprints into ICT policy frameworks
- Provide hardware, spectrum, or cloud resources
- Anchor pan-African federation at Tier 4



The infrastructure Africa needs already exists. Let's deploy it.

 Explore the blueprint:

 Project site: digitafrica.eu

Join the hands-on session tomorrow

On behalf of the DIGITAfrica consortium



Thank you!