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for the responsible
development of
the metaverse

Introduction: Internet Evolution

- Transition from Web 1.0 (read-only) to Web 4.0 (interactive, intelligent Internet)

- Each stage has deepened reliance on connectivity

- The metaverse marks the next major shift in digital interaction

Rise of the Metaverse

Definition: immersive 3D virtual environments enabling real-time interaction

Features: Combines VR, AR, AI, blockchain, and IoT technologies

Key fact: Emerging as a key paradigm for Web 4.0

Metaverse as a Connectivity Challenge

Immersion ➡ High-speed + low-latency Internet is essential

Importance of Infrastructure

Problem in rural or poor areas

Latency and broadband quality as major obstacles.

Dimensions of the Digital Divide

Physical Access: availability of devices and Internet connections

Material Access: ongoing costs like subscriptions, energy, and maintenance

Conditional Access: restrictions due to payment, membership, or roles

Types of discrimination

1) Geographical

- Internet penetration: Africa ~38% vs. Europe >90%
- Smartphone ownership: UK 82%, Pakistan 30%

2) Socio-demographical

Who is affected: elderly, disabled, migrants, rural populations, and minorities

Kinds of barriers: affordability, literacy, and language limitations

UN Framework on Digital Divide

UN (2018): divides by access, affordability, education, gender, and location

Bridging divide is a core UN SDG target (Goal 9)

Rural vs. urban and age-based gaps remain most persistent

Metaverse and Education

- Potential for immersive, experiential learning through VR/XR

- Metaverse classrooms can enhance engagement and retention

- COVID-19 accelerated digital learning but exposed inequalities

Digital Divide in Education

Rich countries (e.g., Switzerland, Japan) lead in metaverse adoption

Costs of devices and bandwidth remain prohibitive in developing regions

Universities → investments in VR infrastructure

Bridging the Divide: Satellite Mega-Constellations

- LEO (Low Earth Orbit) satellites as complementary infrastructure to fiber networks:

1) Provide coverage in remote and underserved regions

2) Can reroute traffic in case of terrestrial infrastructure failure

LEOS' Pros & Cons

Aspect	Pros	Cons
Latency & performance	Very low latency, suitable for real-time services (calls, gaming, critical comms).	Requires constant handover between fast-moving satellites to keep service stable.
Coverage & continuity	Can provide (near) global coverage, including remote and polar regions.	Each satellite covers a small area and moves fast → large constellations needed for continuous service.
Cost & deployment	Cheaper to launch a single LEO satellite than a GEO satellite; allows incremental roll-out.	Overall system is expensive because hundreds/thousands of satellites must be built, launched, and renewed.
Space debris & safety	Lower orbits allow natural decay and easier de-orbiting at end of life.	Mega-constellations increase collision risk and the generation of new space debris.
Market & governance	Drives innovation and new satellite-based services and business models.	Concentrates critical infrastructure in a few private actors, raising issues of competition and sovereignty.

Legal and Policy Concerns

- Spectrum hoarding and 'paper satellites' hinder fair access

- Risks of space debris and unsustainable orbital congestion

- ITU Resolutions 219 & 74 aim to ensure equitable and safe space usage

Power Concentration Risks

- Market dominance by SpaceX (Starlink) and Amazon (Kuiper)

- Potential replication of terrestrial Internet monopolies in space

- Need for global governance to prevent digital inequality in orbit

Toward a Fair and Sustainable Future

- Collaboration among governments, private sector, and NGOs is key

- Integrate sustainability into connectivity expansion

- Ensure universal, affordable, and secure Internet access

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Conclusions

- The digital divide is a serious issue – and it is likely to grow over time if we do not address it

- So far, we have mostly looked to the ground for solutions; now we are starting to look to the sky

- Space offers a powerful opportunity, but it also poses enormous technical, legal, and governance challenges.

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THANK YOU!

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