Wireless Digital Twins: Bridging Real-World Experimentation and Wireless Network Emulation

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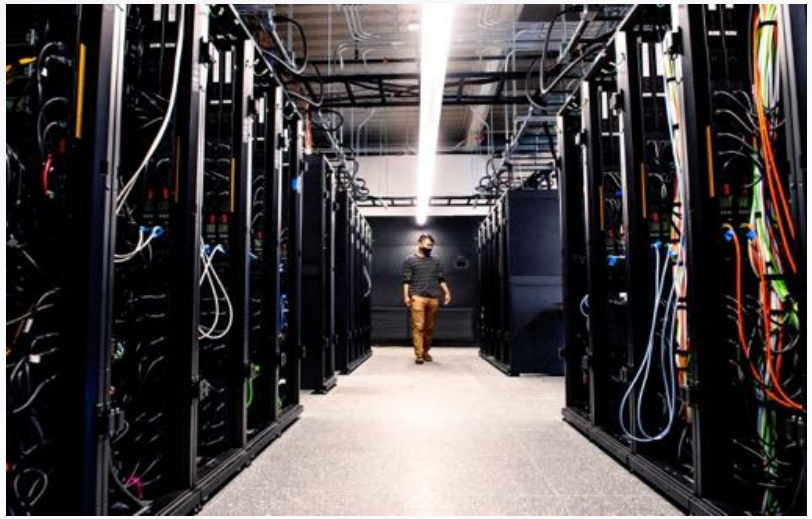
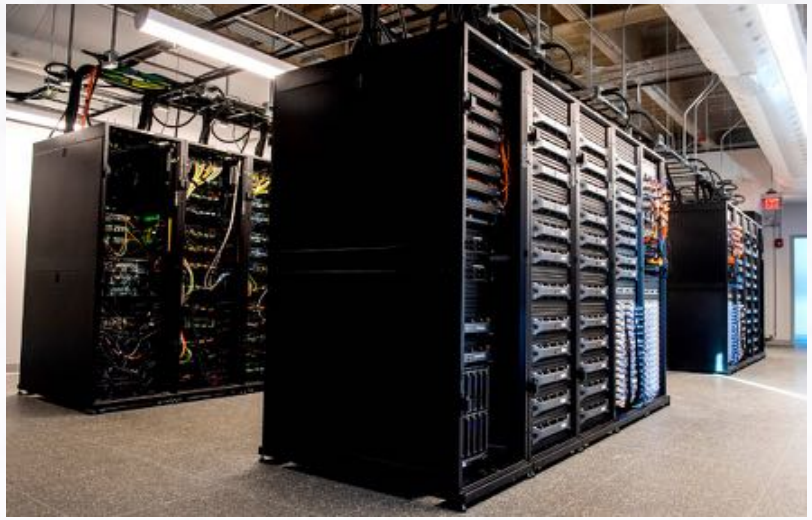
Joint work with T. Melodia, M. Polese, L. Bonati, S. Basagni, D. Villa, M. Tehrani, C. Robinson, and WIoT collaborators

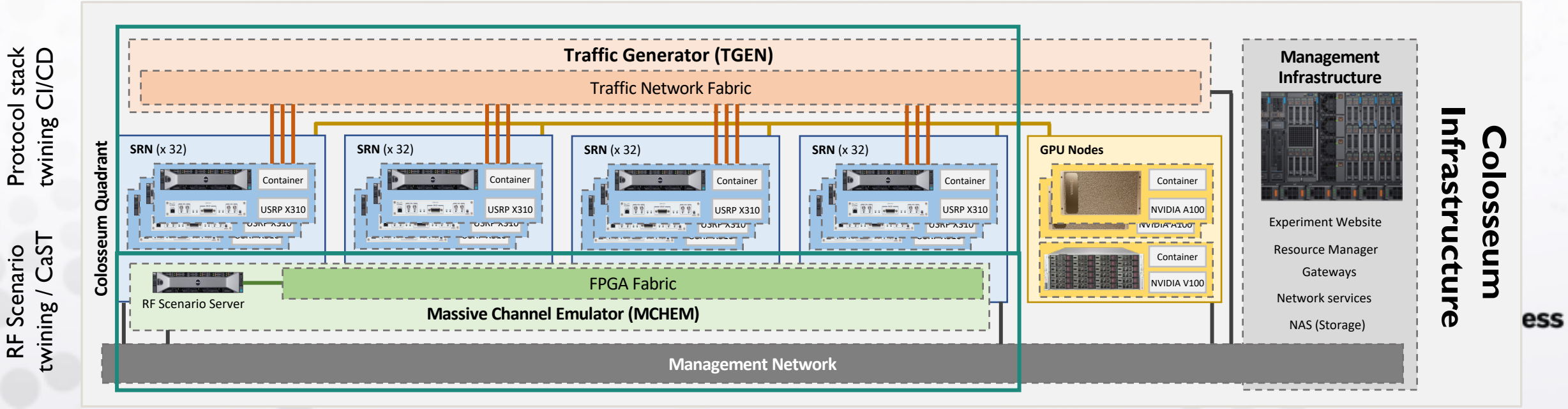
Colosseum: The Open RAN Digital Twin



25 racks with

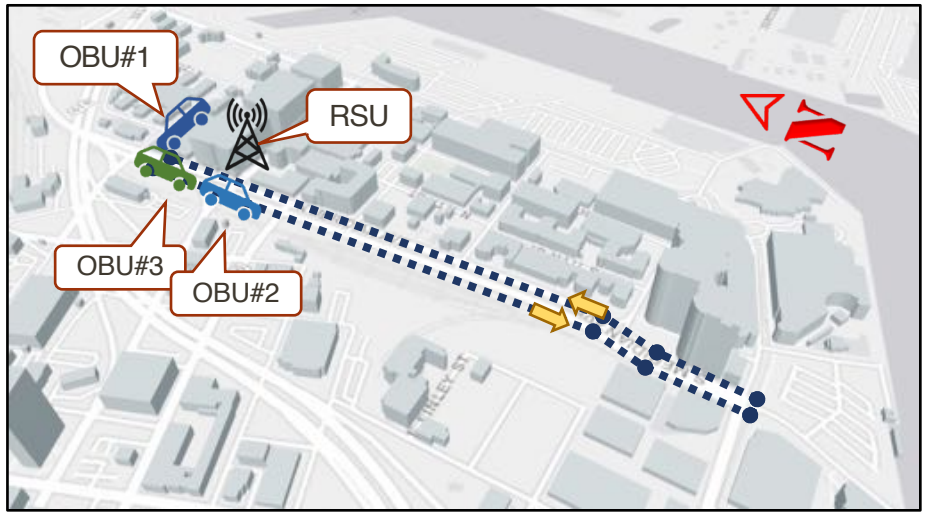
- 256 SDR radio nodes
- MCHEM FPGAs
- NVIDIA DGXs and GPUs
- Dell compute
- SDN infrastructure with SONIC





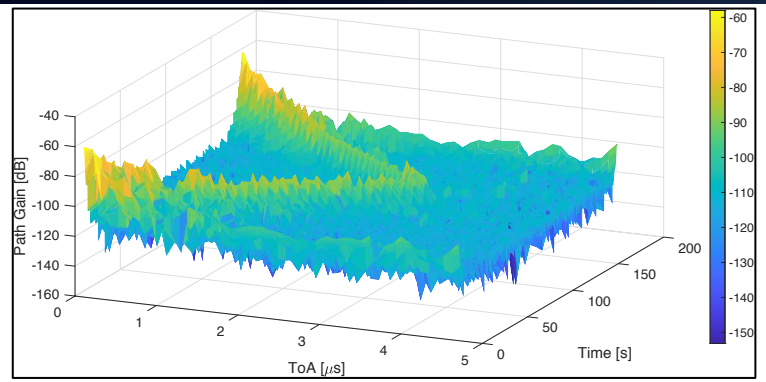
CaST: A wireless Digital Twining toolchain to create and characterize emulated wireless networks

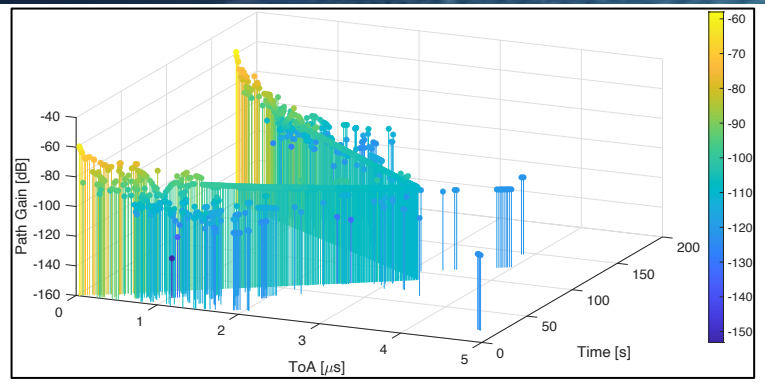
Real World Environment

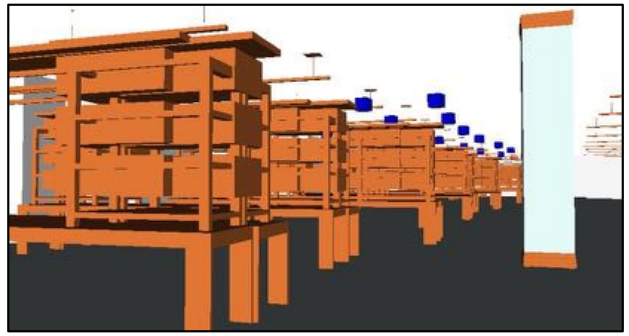


Digital Twin Replica

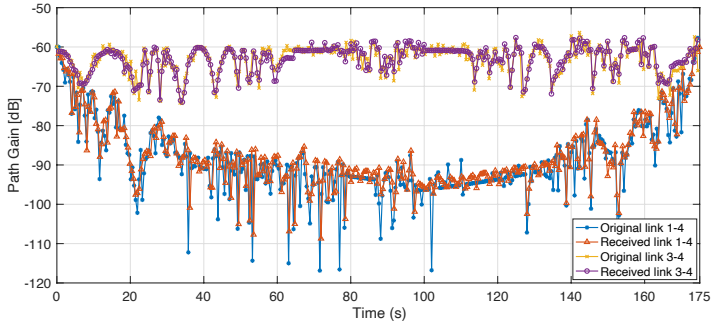
Outdoor Digital Twin, a V2X scenario in Tampa FL

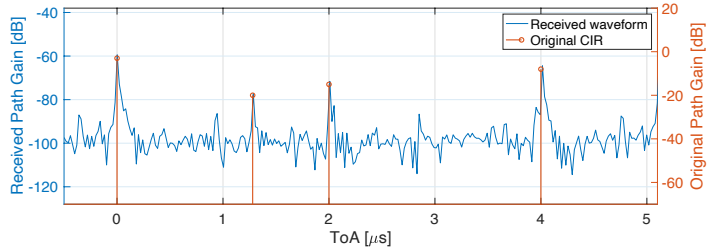






Indoor Digital Twin, Arena & Colosseum





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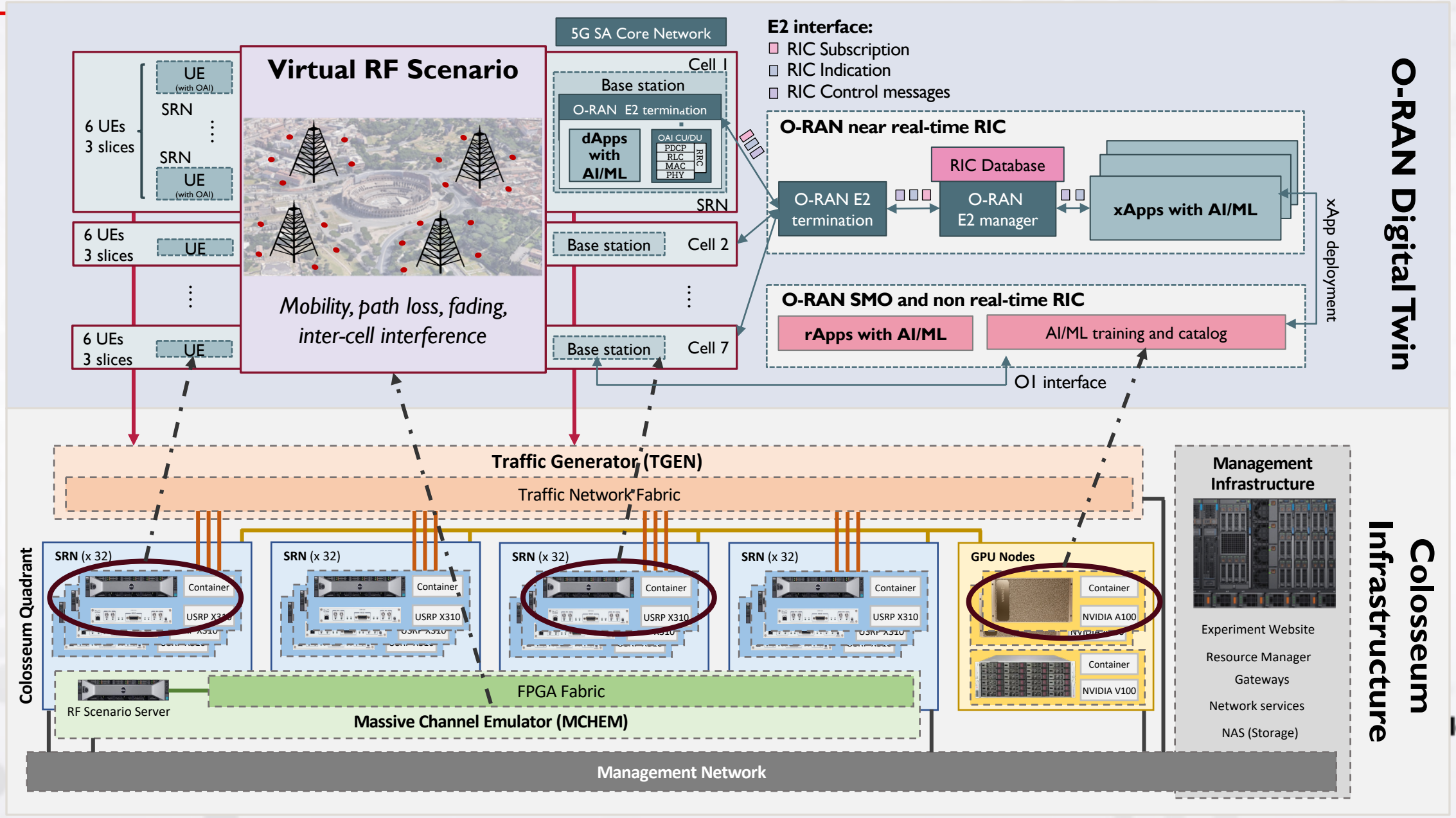
D. Villa, M. Tehrani-Moayyed, C. Robinson, L. Bonati, P. Johari, M. Polese, S. Basagni, T. Melodia, "Colosseum as a Digital Twin: Bridging Real-World Experimentation and Wireless Network Emulation," arXiv:2303.17063, March 2023.

Colosseum: The Open RAN Digital Twin



Open RAN Digital Twin

Open RAN + MEC

OpenRAN Gym

O-RAN ALLIANCE

SMO + data collection platform

ML Training Nodes
2x NVIDIA DGX A100 - SuperMicro server w NVIDIA V100

Colosseum Data Storage

xApp Catalogue

Non-RT RIC

ColO-RAN Near-RT RIC

xApp SDK

xApp

xApp

xApp

Redis Database

E2 Routing Manager

E2 Manager

E2 Termination

Micro-services Cluster

Open interfaces and data pipelines

Core network

EPC and 5G Core on a micro-service-based architecture

Open5GS

OPEN AIR INTERFACE

5G Core UPF AMF SMF …

4G EPC S/PGW MME …

RAN-in-a-box

Softwarized, open-source 4G/5G and beyond RAN

LTE eNB

RRC
PDCP

RLC
MAC
PHY

OPEN AIR INTERFACE

Disaggregated NR gNB

O-CU-CP

RRC
PDCP

O-CU-CP

O-CU-UP

O-DU

O-CU-UP

SDAP
PDCP

O-DU

RLC
MAC
PHY-high

Scrambling
Modulation
Layer mapping
Precoding
RE mapping

O-RU

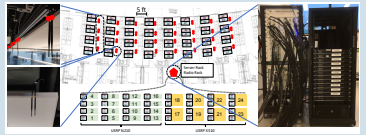
PHY-low
RF

Precoding
iFFT/CP
Beamforming
DAC/ADC

Experimental platforms and testbeds

Colosseum

Arena and X-Mili



PAWR Platforms