OFCity 2017
Abstracts from the Teams

Introduction:

The Connected OFCity Challenge team competition, first held during OFC 2016, is a platform to discuss technological innovations required for a smart city project. The OFCity Challenge returns this year to debate technical solutions for enabling advanced services in a smart city, building upon the results of last year's competition.

This time, the OFCity Council is planning the Septicentennial (700-year anniversary!) celebration in 2023 and once again organizes an open competition to select the best proposal for the preparation and broadcasting of the Septicentennial Concert and three major sports events.

Four multidisciplinary teams comprising experts from a cross-section of industry and academia will compete to recommend innovative optical solutions and complementary technologies to realize the required services. The teams will be judged both on their ability to provide high bandwidth, low latency, and high network reliability solutions, but also on the creativity and practicality of their solutions. Two distinctions, Judges' Award and Audience Award, will be handed out at the conclusion of the competition.

Real-life Virtual Reality (VR) demo and complimentary VR viewer:
As a key element of this event will focus on enabling low latency VR, a special VR demo will be held during the intermission. A limited quantity of complimentary Virtual Reality viewers will be available to the audience – first come, first served.

Team Terapolis:

Dimitra Simeonidou (Leader)	Professor, University of Bristol, UK
Harald Haas	Professor, University of Edinburgh, UK
Stephen Hilton	Managing Director, Bristol Futures, UK
Sergi Figuerola	CTO, i2CAT Barcelona, Spain

OFCity: An Enlightened City

Terapolis is a leading urban visionary consultancy with a single focus to empower cities in reaching their goals. We have been working with OFCity for a number of years evolving the infrastructure towards full optical connectivity: from fiber to LiFi. Our vision is to deliver a hyper-connected, data rich, green city infrastructure; a thriving digitally-enabled local economy and the well being of all citizens.

Technology will transform the OFCity citizens' lives, work, transport and entertainment but it will be seamless and adaptable to their needs.

We have been asked to plan the OFCity's 700 year anniversary with a festival that will showcase world leading digital interventions and will leave a sustainable legacy.

Our proposal will deliver a set of applications for a sports festival, for a full week in Summer 2023, showcasing "speed of light" experiences.

Our aim is to make citizens' and visitors' experience "better than the real thing" and the athletes' experience "frictionless". It will be the most interactive and inclusive sporting event ever.

We will present our plans to the OFCity Council and their advisors on the 20th of March, during OFC 2017 in LA.

We understand that this will be a competitive process but we are confident of our leading position.

Team ALIVE

Marco Ruffini (Leader)	Professor, Trinity College Dublin, Ireland
Thomas Pfeiffer	Group Leader, Nokia Bell Labs, Germany
Dave Hood	Systems Engineer, Huawei, USA
Junwen Zhang	Research Engineer, ZTE, USA
Daniel King	Senior Researcher, Lancaster University, UK

The Augmented Living Experience (ALIVE) team is tackling the challenging problem of delivering highly predictive deterministic packet transport for high fidelity acoustic and video applications. Our use cases are based on the requirement to schedule connectivity and maintain specific low latency network guarantees for remote multi-site locations for real-time concert rehearsals, and sport streaming.

We achieve our objectives by employing a software-defined controller over a hierarchical multi-layer network architecture that utilises transparent metro optical switching, and strict-QoE traffic engineered packet paths across packet core infrastructure. Guarantees are provided via in-situ OAM monitoring and feedback to the controller.

Network connectivity is complemented with sound and augmented reality (AR) video processing and synchronisation methods, tightly interacting with the network controller which modifies QoE paths accordingly and ensures seamless protection switching.

Additional key contributions include integrated fiber-wireless access network and Geo-distributed Fog Computing technologies, which allow predictive network connectivity for time-sensitive and ultra-reliable communications such as: autonomous vehicles, localised content delivery and live augmented reality concert and sport streaming.

Team ALIVE will present a cost-effective solution for smart ultra-low-latency communication providing a long-lasting legacy to OFCity, demonstrating its technology leadership in the area of 5G smart cities for many years to come.

Team FIBRUS

Luca Valcarenghi (leader)	Professor, Scuola Superiore Sant'Anna, Italy
Rajesh Yadav	Lead Network Architect, Verizon, USA
Hal Roberts	System Architect, Calix, USA
Nicola Sambo	Scuola Superiore Sant'Anna, Italy
Silvia Fichera	Scuola Superiore Sant'Anna, Italy
Marcello Carrozzino	Scuola Superiore Sant'Anna, Italy
Franco Tecchia	Scuola Superiore Sant'Anna, Italy
Marco Tacca	University of Texas at Dallas, USA

In 2023 OFCity citizens will enjoy music, sport competitions, and autonomous cars all enabled or enhanced by communications technologies. The utilized solution will be a mix of wired and wireless technologies to guarantee the applications with the required capacity, latency, and jitter but with some peculiarities. Musicians will be capable of rehearsing remotely only if located in places no farther than 20 ms in latency. Tests have shown that this time cannot be computed simply by distance (e.g., Pisa-Dallas about 9000km – 45 ms) but should be based on layer three latency (e.g., Pisa-Dallas 145ms). Thus solutions shall be targeted in which the number of traversed equipments is minimized (i.e., reducing the store and forward delay), access network latency is low (i.e., PONs with short cycle time, few multiple access wireless technologies), locations are close, and top class Analog to Digital/Digital to Analog (AD/DA) converters are used.

Athletes will be capable of rehearsing remotely in an immersive environment (e.g., Oculus like) where they will experience 360° Virtual Reality with 4k resolution with sensorial feedback (e.g., uphill or downhill slope) as well events will be broadcasted live in 3D 360° with 4k resolution which VR/AR technology should support in 2023 time frame. This setup will require bandwidth on the order of 1Gbps – 5 Gbps per VR stream. 10G PON and/or multiple 10G PON systems will be capable of providing the desired, scalable bandwidth to event locations. Advanced VR solutions could be implemented to reduce the required bandwidth. For example only the 90° athlete view could be transmitted with the rest of it stored at fog nodes for fast transmission in case of sudden movements. This solution does increase the need for lower latency. The VR experience for mobile devices would be encoded at lower rates to allow for transmission over 4G/5G wireless connectivity.

For OFCity to use autonomous vehicles, they must be autonomous without the need for *any communications network* much less a high availability low latency one. This is necessary since any car/car, car/curb or car-DC-car must be wireless and may not always be available. That is not to say autonomous cars cannot *benefit* from such a system. For example sensors installed on stoplights can signal to cars, equipped

with low latency wireless receivers, potential risks (e.g., a human driven car running a red light). In this case connectivity must be wireless and latency may be reduced as the communication is local and does not need to connect with low latency to the cloud. Ultra-reliability is not needed as only intersections with such blind spots will need them at first. In another example, for autonomous cars to take advantage of real time, detailed local maps a pervasive infrastructure is needed. Ultimately, cars will become a mobile living room that will need all the communication capabilities of a home, only it must be wireless based. In OFCity, 5G base stations transmitting sensor, map and entertainment data may be installed on stoplights or light poles fed by high capacity terrestrial access networks such as 10GPON to enhance the capabilities of autonomous vehicles.

Team VUTOPIA

Naoto Yoshimoto (Leader)	Professor, Chitose Institute of Science and Technology, Japan
Elaine Wong	Professor, University of Melbourne, Victoria , Australia
Ning Cheng	Principal Engineer, Huawei, China
Yuki Yoshida	Planning Manager, NICT, Japan

To the opportunity of Septicentennial (700-year anniversary) celebration in 2023, OFCity council has declared VUTOPIA vision that this city will be rebuilt and developed an attractive town for a worldwide R&D base and testbed field for networking and related services, as well as historical sightseeing spots.

VUTOPIA world is a cyber city on real world OFCity where the citizen can experience much VR/AR applications and autonomous driving with time critical response by using delay-sensitive and high-capacity network infrastructure.

To realize VUTOPIA world, OFCity council has invested "all-spectrum testbed" at the center of the city for providing high-capacity and time-critical applications. For example, high-quality VR experience for the memorial concert can be provided by connecting the testbed with MMW link, and for VR sports experience and training in rural areas by rapidly deployable MMW RRH.

To develop and utilize VR/AR application easily and efficiently, OFCity council has prepared development environment for VUTOPIA application platform and all-spectrum resource virtualization function using SDN-orchestration and AI-networking technology.

As a result, startup ventures and researchers can utilize the state of the art test-bed based on delay sensitive real-5G radio access and can perform various new service verification, and also the citizen and tourists can have real high-level VR/AR experience.

Now, could you please invest VUTOPIA world and join the testbed of real 5G networking and applications?