

# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

## INNOVATION DEMOS

### Nokia Bell Labs Future X Experience – 22 demos

Visitors can take a demo tour into the network of the future – a massively distributed, cognitive, continuously adaptive, learning and optimizing network connecting all humans, all senses, all things, all systems, all infrastructure, all processes.

**The Future of Networked Interactions:** see how advanced machine learning techniques leverage collections of sensors and devices to make our environment reveal emotions and contexts, in an evolution to the Future of Augmented Internet Experiences.

#### 1 Fractal and hyperfractal wireless networks

Next-generation wireless networks consist of very diverse communication scenarios. These scenarios require innovative and accurate models. Our idea is to get inspiration from nature! We will exploit self-similarity for building realistic flexible models and see how this boosts performance and improves reliability.

#### 2 Future(Trust+Spaces)

Each new connected device in a home is a source of security or privacy risk. In this demonstration, we show how the joint use of blockchain technology to help assess the trustworthiness of a device and of an intelligent SDN-based network manager allows to greatly limit this risk.

#### 3 Intuitive deployment of inter-personal IoT services

At the advent of a fully connected world, discovering and deploying IoT services still represents a complex task for end-users. In this context, this demo highlights an automated discovery of connected devices with their functionalities and then the automated discovery and deployment of IoT services through a modular SDN-based platform.

# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

## 4 Sustainable cryptocurrencies for everyday digital transactions

Cryptocurrencies like Bitcoin owe their success to the fact that they link their security properties to an economical incentive. While initially subsidized by creation of new currency units, transaction fees are eventually supposed to become the main reward for the nodes that run the network and guarantee the security of transactions. In this context, it is an open problem how to implement proportional fees to allow a sustainable growth of the cryptocurrency ecosystem. In this demo, we propose a volatile cryptocurrency that follows a new validation criterion: we enforce nominal devaluation on a per-block basis to enable fees that are proportional to the transacted amounts. To compensate for volatility, we introduce an external incentive tied to proof-of-work for encouraging node participation.

## 5 Indium phosphide detector towards unified electronics technology for terahertz applications

The terahertz gap is addressed today with multiple different photonics and/or electronics technologies. Indium phosphide (InP) electronics is increasingly improving towards and beyond today's best niche technologies for power generation up to 1 THz. We have proven that InP electronics can also become a high performance detector, opening the way to low-power and compact integrated transmitter and receiver THz solutions for as various applications as security, non destructive testing, and ultra broadband short distance connectivity.

## 6 Intent-based networking (IBN) for real-time 5G cloud service provisioning

This demo shows integration of Intent-based network slice setup for real-time 5G cloud using FX CRAN platform. Example scenario would be on-demand Video/IoT slice setup while hiding network reconfiguration complexity from customer. The system exposes a non-expert-friendly interface to 5G network reprogramming while achieving real-time latencies and throughputs.



# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

**The Future of Networked Networks:** Experience the automation of industries and infrastructure and the underlying digitization and connection of everything, everyone, and every system and process.

## 7 5G Massive MIMO/BF with 3D content aware energy efficiency

5G Massive MIMO is a great opportunity to offer spectral & energy efficiency. But optimum performance implementation requires huge transceivers count that consume a lot! So how to make the equipment energy efficiency not jeopardized? Bell Labs smart beamer, multi user inter beam interference reduction, joint content aware clipping algorithms and smart biasing adapt each Power Amplifier working points in real time according to the instantaneous PRB & spatial usage. Signal distortion is kept low enough to offer 5G high throughput in any modulation mix up to 256QAM. As a result, Bell Labs demonstrates dramatical mMIMO machine energy improvement with up to 10X at low load!

## 8 Deep learning-based communication over the Air

End-to-end learning of communications systems is a novel concept that has so far been only validated by simulations. It allows learning of transmitter and receiver implementations-without any prior knowledge-that are optimized for an arbitrary differentiable end-to-end performance metric, e.g., block error rate (BLER). We present in this demo a prototype of the world's first communications system whose physical layer is entirely learned and implemented as a deep neural network.

## 9 Future X-Haul with deterministic network

Cloud-RAN, 5G, microservices have all in common stringent latency requirements. Few milliseconds are left for packets transport in network. Traditional statistical multiplexing leads to a costly and limited range point to point architecture. The demo shows the benefits of deterministic networking, allowing to use shared network for X-Haul in 5G and beyond services.

## 10 Metrology of C-RAN

The C-RAN architecture requires the eNB function to be split into several parts that will be executed on distinct locations (antenna site, cloud platform...). The major challenge is to determine the best split variants that will fulfill current and future real-time constraints. We compare and analyze metrics of critical code parts in real and simulated environments to determine the key factors of variants.

# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

## 11 Flexible gNB

Wireless access, as deployed by traditional providers is a rigid infrastructure, mainly optimized to serve smartphone usages. We demonstrate how this infrastructure will evolve toward a modular, flexible set of "microservices" which could be deployed to support various devices traffic models and various business models.

## 12 Optimized security response plan generation

Risk management of complex systems is a hard and tedious process, mainly based on human expertise. We pioneered a technology suite that helps security officers up to the risk assessment step. Going a step further, we show how we compute optimized response plans by the combination of new models and modified flow graph algorithms applied on attack graphs. The technical demonstration will be based the interaction of our prototypes and the Nokia Innovation Platform in Paris-Saclay.

## 13 Easy optical defragmentation as a service

We propose an easy deployment of your own application where you can subscribe to any implemented & authorized optical monitored parameters with no manual intervention. Monitors are self-discovered via new programmable data plane elements and supported by novel intent monitoring framework in our NetUNIX SDN controller. We finally showcase defragmentation-as-a-service.

## 14 High capacity optical transmission

We demonstrate capacity approaching wavelength division multiplexed optical transmission in the lab. The demo will be based either on constellation shaping with non linear compensation or on ultra-wideband amplification.



# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

## 15 CliMBOS: a high-density NFV execution platform

Network Function Virtualization strives to replace monolithic functions, implemented in hardware or as full-fledged VM images, with nimbler virtualized network functions (VNFs) running on shared infrastructures. Based on Click and Mini-OS, CliMbOS allows high-density deployment of modular VNFs supporting full-stack network semantics by leveraging our 10X Modular Data Plane framework. CliMbOS is capable to execute hundreds of isolated NFs on a single server providing high-performance in terms of VNF spawn time and service latency.

## 16 Electronic-photonic integration for future 100/400 Gbit/s client interface

Bell Labs demonstrated 1st co-packaging of ultra high speed MUX-PDAC and modulator to deliver >100G per channel transmitter module for client interface. This digital/analog integrated transmitter avoid high speed connectors, enabling cost reduction of 100 G interface and paves the way for 200G interface due to better signal integrity.

## 17 High-power high-speed transmitters with different intensity modulation formats

III-V Lab has developed high power integrated laser / electroabsorption modulators at 1.55 $\mu$ m demonstrating 28Gb/s NRZ operation with +6dBm average power. A set-up has been developed with systems team to test these devices with DAC and drivers in system configuration, comparing advanced modulation formats (NRZ, PAM4, DMT) to reach higher bit rates.

**The Future of Networked intelligence:** Explore and interact with information, content, and sensor/device streams to convert the torrent of unstructured and disjoint data into useful information and automated actions.

## 18 Unleash the potential of coherent optical technology

Current coherent technology extends, beyond high speed optical transmission systems, to unexplored features from live optical network planning and optimization to distributed mechanical sensor with an unrivalled sensitivity. Three applications are presented: automatic recognition of fiber types, proactive detection of fiber breaks, distributed sensing using new probing codes.

# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



NOKIA

## 19 Machine-learning based mobile network predictive resource control over microservices: application to IoT slicing

In this demo, we shall demonstrate, dynamic prediction of mobile network micro-services placement, auto-scaling and network prediction programming to fit with SLO (Service Level Objectives). A complete Mobile Network slices will be instantiated with different IoT types traffic load.

## 20 Self-adaptive resource management with reinforcement learning

We demonstrate the automatic learning of scaling policies through Reinforcement Learning for a Cloud-based web application. The method learns optimal policies with few application details and adapts automatically to changes in application workloads and infrastructure capacity. Moreover, we enhance the standard Reinforcement Learning by injecting small resource perturbations (stimulus) to accelerate the learning.

## 21 Active learning for inference in expert systems

Expert systems such as stock exchange or customer-care centers consist of experts of varying expertise and quality, tasked with providing answers to questions of varying types and difficulty. A major challenge in such systems is assigning an arriving task, whose type and difficulty are unknown a priori, to an expert capable of providing an answer. We develop active learning algorithms to infer an incoming task's type and to assign it to experts, with the objective of processing the task quickly.

## 22 Enabling loop-free convergence in an IGP network

What makes the Internet routing scale is its underlying routing protocols, whose efficiency comes from decentralization. However, the price to pay is that failures are not recovered instantaneously. This may provoke traffic losses. The demonstration will present a new protection mechanism able to quickly protect the traffic in such situations.



# Nokia 5G smart campus event

October 11th

We create the technology to connect the world



**NOKIA**

## Nokia Innovation Hub – 2 demos

### 23 Reloading NOKIA Garage Paris-Saclay

After 3 years of experimenting the concept, Nokia Garage Paris-Saclay new ambition is to foster co-innovation and cross-fertilization of the numerous innovation initiatives on NOKIA Paris-Saclay campus along with external teams from Paris-Saclay Innovation cluster (such as startup in residence/students). Come and Discover the new space and how this playground could be yours to innovate differently with no fear to fail.

### 24 The Nokia Innovation Platform

The Nokia Innovation Platform provides a live development and trial environment for start-ups, industries and other partners to accelerate innovation of IoT solutions through an open, collaborative model. It enables innovation projects in the real world with customers and ecosystem partners, in the area of transportation, cities, public safety, industry and health.

## Innovation for Verticals – 3 demos

### 25 Connected smart factory

360 degrees visit of the Boston Consulting Group (BCG) factory.

### 26 Video analytics for smart city

Demonstration of how video analytics is supporting Paris-Saclay smart city innovation.

### 27 Mobility services for mobile citizens

Demonstration of mobile services for connected citizens with our partner Colas.