Panel on Digital Delivery of Media Services

MATILDA

5G PPP

A HOLISTIC, INNOVATIVE FRAMEWORK FOR THE DESIGN, DEVELOPMENT AND ORCHESTRATION OF 5G-READY APPLICATIONS AND NETWORK SERVICES OVER SLICED PROGRAMMABLE INFRASTRUCTURE

Digital Media Application Services in 5G: Orchestration, QoS/QoE and energy efficiency

Franco Davoli

DITEN-University of Genoa, Italy

CNIT (National Inter-University Consortium for Telecommunications) – National Laboratory of Smart, Sustainable and Secure Internet Technologies and Infrastructures (S3ITI)

TNT

http://www.tnt-lab.unige.it
http://www.cnit.it/en/institutes/s3iti/

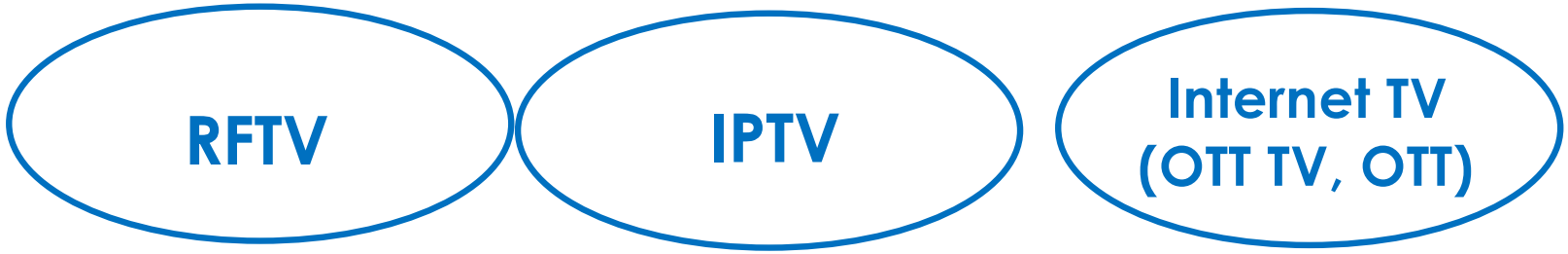
DITEN

cnit

A short account on Video Distribution Networks

Source: R. Bolla, R. Bruschi, F. Davoli, E. V. Depasquale, "Energy-efficient management and control in video distribution networks: "legacy" hardware based solutions and perspectives of virtualized networking environments", in A. Popescu, Ed., *Guide to Greening Video Distribution Networks - Energy-Efficient Internet Video Delivery*, Springer, 2018, pp. 25-57; ISBN: 978-3-319-71717-3.

Genres of Video Distribution Networks



- Formatting & source encoding
- Managed network w/ QoS (circuit-like in path selection)
- Broadcast

- Formatting & source encoding + Protocol Architecture
- Managed network w/ QoS (more flexible path selection)
- Live multicast / unicast VoD

"Walled garden" (QoS under direct VSP control)

- Formatting & source encoding + Protocol Architecture
- Unmanaged network w/ dynamic adaptive streaming over HTTP
- Delivered over an intermediate network that is owned by an arbitrary combination of third parties
- CDN

Network outside of direct VSP control

IPTV and OTT TV

- Content
  - Real-time ("linear"; e.g., sports, news, live events)
  - Stored content (VoD, OTT-CDN)
- Linear TV QoE and reliability difficult problems to solve for an OTT-VSP without the combination of two stages of the delivery network:
  - Internet core
  - Regional network

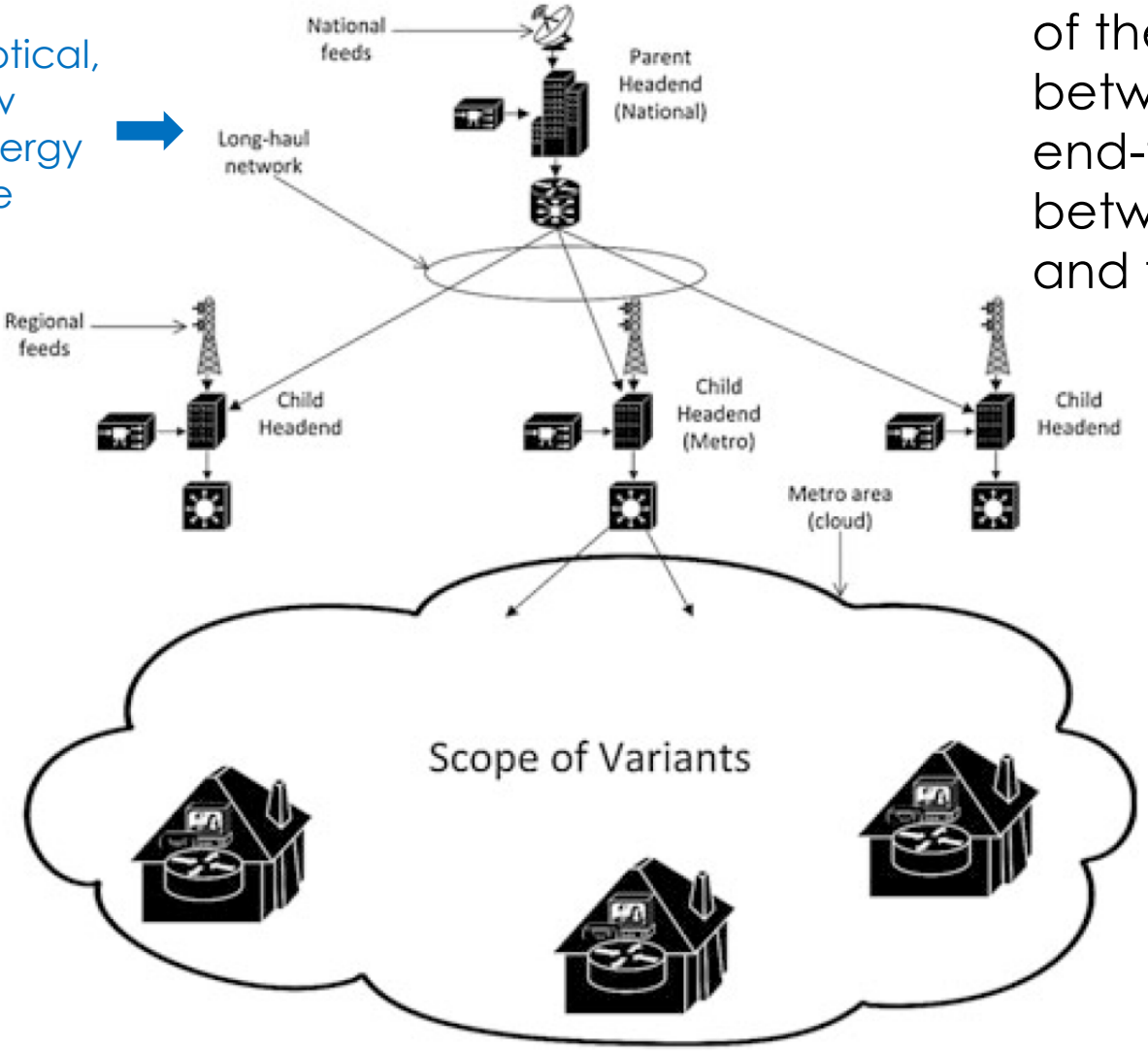
  through
  - Customized cascading (contracts w/ Tier-1 ISPs & Regional ISPs)
  - Turnkey cascading (Multi-CDN – contracts w/ multiple CDN operators)

IPTV and OTT TV

- The IPTV-VSP typically owns the network and is classifiable as a Network Provider (e.g., an incumbent in the telecommunications operators' field)
- The OTT-VSP typically owns a part of the network (e.g., an incumbent in the field of acquisition of content rights)

IPTV VDN Template

Optical, low energy use



IPTV implementations are diverse as a result of the decoupling between IP and the end-to-end path between the headend and the end-user

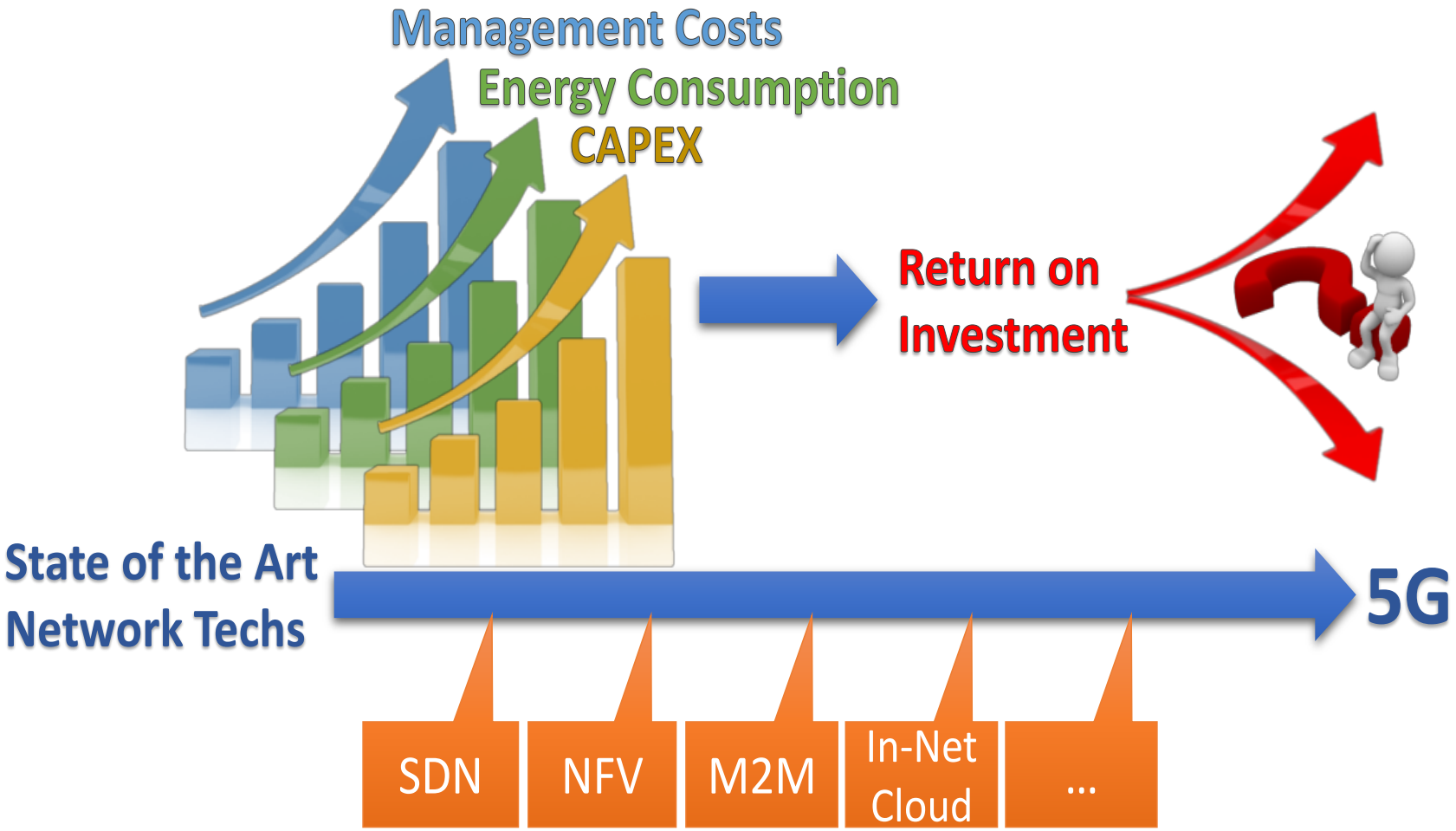
The scope for variants lies within the access and backhaul (metro-aggregation) segments and most notably within the access segment

Space for flexibility, QoS/QoE, energy efficiency, 5G

Trends

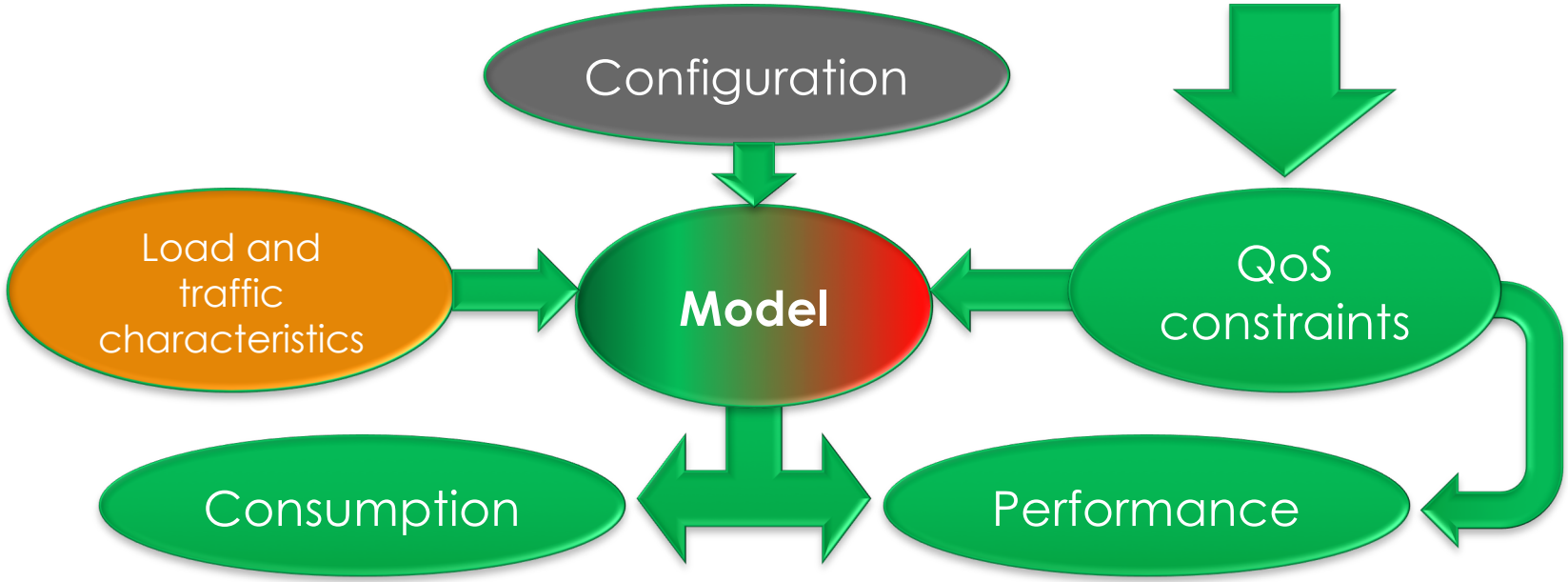
- In network providers' technology space, the convergence of communications and information technology is shaping the design of the CO/LE (CORD: central office re-architected as a datacentre) and the headend (HE; HERD: head office re-architected as a datacentre)
- Flexibility is obtained through *softwarization* (SDN) and virtualization (NFV)
- It seems reasonable to anticipate that the logical culmination of CORD and HERD is a single datacenter architecture in which all functions are implemented on virtual deployment units in a pool of general-purpose servers, under the orchestration of QoE- and energy-oriented video service applications, running on a network operating system

Dilemmas


Management Costs
Energy Consumption
CAPEX
Return on Investment
State of the Art Network Techs
5G
SDN
NFV
M2M
In-Net Cloud
...

Dynamic Adaptation

Need to model devices in terms of consumption and performance versus loads and configurations to trade-off performance and power consumption



Energy efficiency – The role of the GAL

Environmental Engineering (EE);
Green Abstraction Layer (GAL);
Power management capabilities of the future energy telecommunication fixed network nodes

A simple method to expose energy-related parameters to the management entities inside the device architectures and to the management plane

R. Bolla, R. Bruschi, F. Davoli, P. Donadio, L. Fialho, M. Collier, A. Lombardo, D. Reforgiato, V. Riccobene, T. Szemethy, "A northbound interface for power management in next generation network devices", IEEE Communications Magazine, vol. 52, no. 1, pp. 149-157, Jan. 2014.

However, how to extend the concept to NFV?

- Main challenge: the correspondence between the HW that consumes energy (and belongs to the Infrastructure Provider) and the virtualized objects (VMs, containers, …) that execute Network Functions (and belong to the Network Service Provider) is not so straightforward as in the legacy environment:
  - Execution mediated by the hypervisor and its scheduling policies;
  - Multiple tenants;
  - No "direct" relation between virtual resources (e.g., vCPU) and *Energy Aware States* of the HW.

GALv2

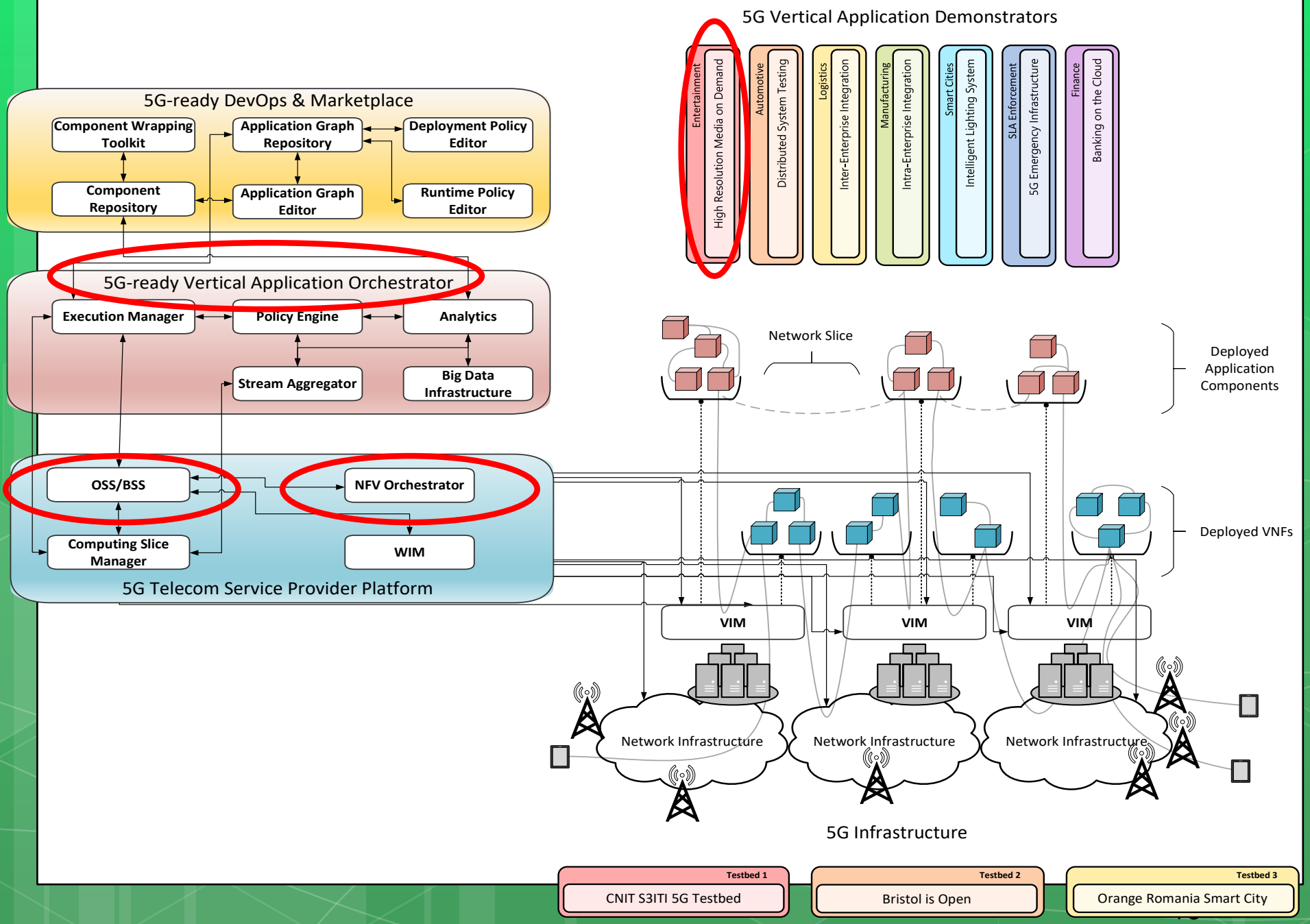
- Use of "virtualized" Energy Aware States as backpressure from the Infrastructure Provider to create incentives toward tenants to become energy-aware.

Towards 5G:

MATILDA - A Holistic, Innovative Framework for the Design, Development and Orchestration of 5G-Ready Applications and Network Services over Sliced Programmable Infrastructure

MATILDA

- Define appropriate **abstractions for the design of 5G-ready applications**;
- Develop an **agile programming and verification platform** for developing and verifying **industry vertical 5G-ready applications** and **network services**;
- Support mechanisms for **automated or semi-automated translation of application-specific** requirements to **programmable infrastructure** requirements;
- Support **intelligent orchestration mechanisms** for managing the entire lifecycle of 5G-ready applications and network services;
- Support mechanisms for **multi-site network, compute and storage** resource management;
- Involve **key actors of the value chain** in the operational model.


5G Vertical Application Demonstrators
Entertainment
High Resolution Media on Demand
Automotive
Distributed System Testing
Logistics
Inter-Enterprise Integration
Manufacturing
Intra-Enterprise Integration
Smart Cities
Intelligent Lighting System
SLA Enforcement
5G Emergency Infrastructure
Finance
Banking on the Cloud
5G-ready DevOps & Marketplace
Component Wrapping Toolkit
Application Graph Repository
Deployment Policy Editor
Component Repository
Application Graph Editor
Runtime Policy Editor
5G-ready Vertical Application Orchestrator
Execution Manager
Policy Engine
Analytics
Stream Aggregator
Big Data Infrastructure
OSS/BSS
NFV Orchestrator
Computing Slice Manager
WIM
5G Telecom Service Provider Platform
Network Slice
Deployed Application Components
Deployed VNFs
VIM
VIM
VIM
Network Infrastructure
Network Infrastructure
Network Infrastructure
5G Infrastructure
Testbed 1
CNIT S3ITI 5G Testbed
Testbed 2
Bristol is Open
Testbed 3
Orange Romania Smart City