BT Group

Dissecting what 5G Service Assurance really means

Achilles Petras

Self Learning Networks

Accomplished Engineer & Research Manager

Realising Enabling Architectures and Solutions for Open Networks (REASON)

A UK Government research project funded by the Department for Science, Innovation and Technology within the Future Open Networks Research Challenge (FONRC) programme.

Universities: University of Bristol, Queen's University Belfast, King's College London, University of Southampton, University of Strathclyde Glasgow

Digital Catapult: Catapult Digital

Vendors: Ericsson, Nokia, Parallel Wireless, Samsung

Service/ Content Providers: BT, BBC

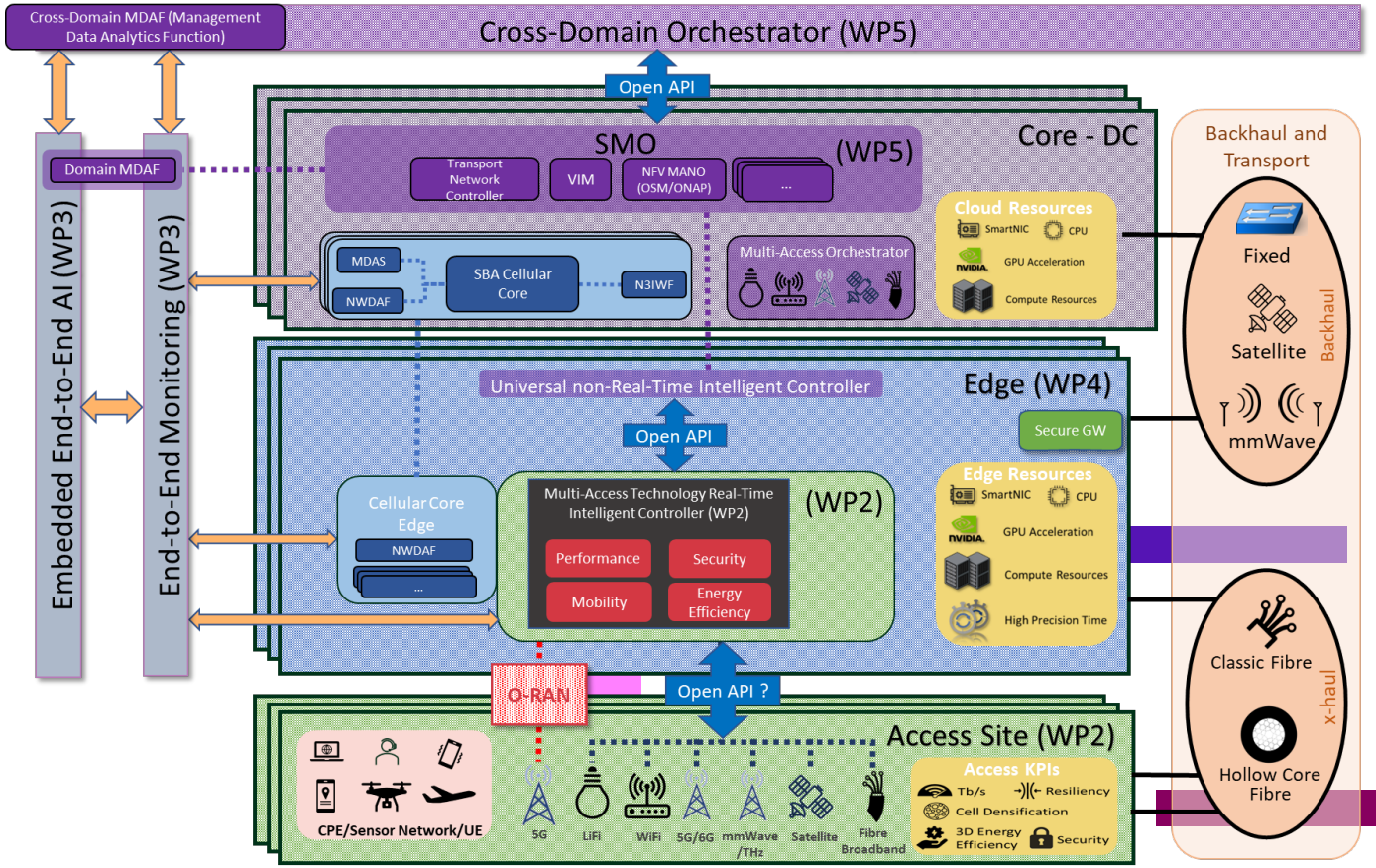
System Integrator: Thales

SMEs: realwireless, weaver labs

Technology Suppliers: connected

5

REASON 6G

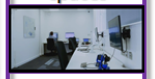


Converged Networks - Research Work Areas and key projects

Wireless Research

- Ultra-MIMO/Air Interface Evolution
- RAN Architecture Evolution
- Back/fronthaul & Satellite

Co-innovation spaces

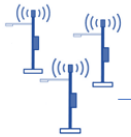


Customer Showcases

Macro cellular MIMO 5G NSA

Mobile Edge Compute

5G Stand Alone Testbed

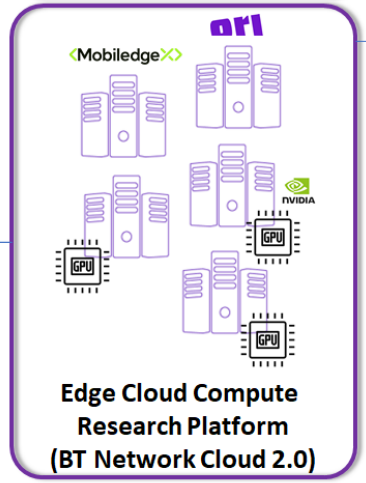


O-RAN Small Cell Testbed

4G Private Network in a Suitcase

Convergence Testbed

5G Core Testbed



Edge Cloud Compute Research Platform (BT Network Cloud 2.0)

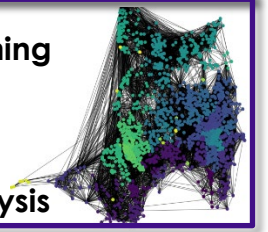
Test & Development Mobile Core *(Borehamwood)*

Core Network & Services

- Network Differentiation for New Services
- Core Network Automation

Self-learning Networks

- Smart Capacity Planning
- RAN Automation
- Converged QoE analysis

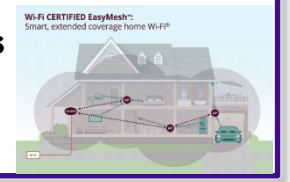


Testbeds and Trials

- 5G use cases
- Network differentiation testbed
- Co-innovation and experimentation

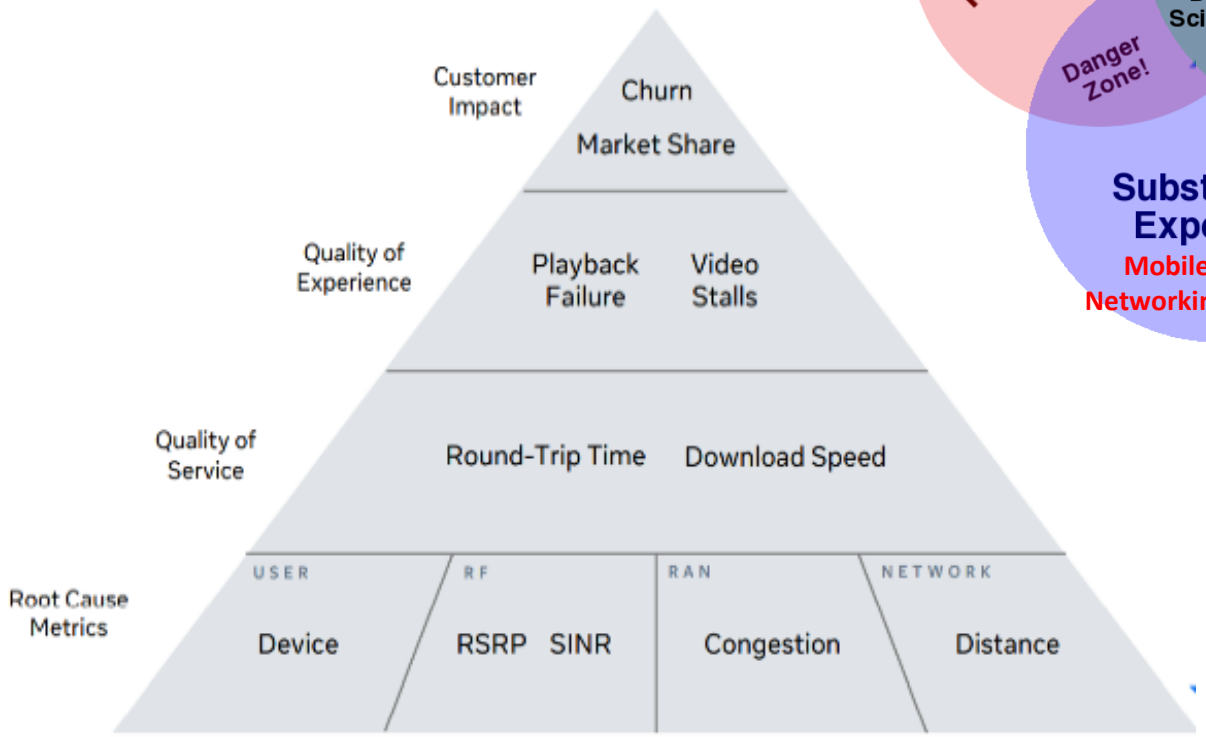
Wi-Fi & In-Home Networks

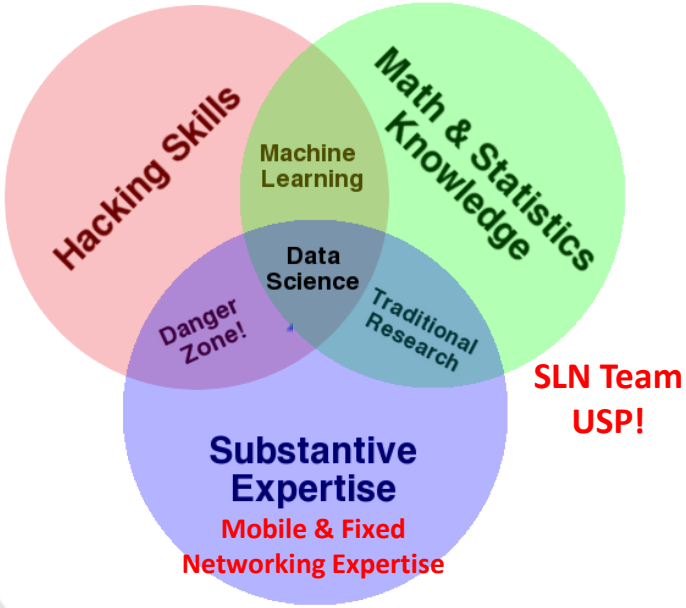
- Wi-Fi Performance and CEx
- In-home Diagnostics
- Convergence



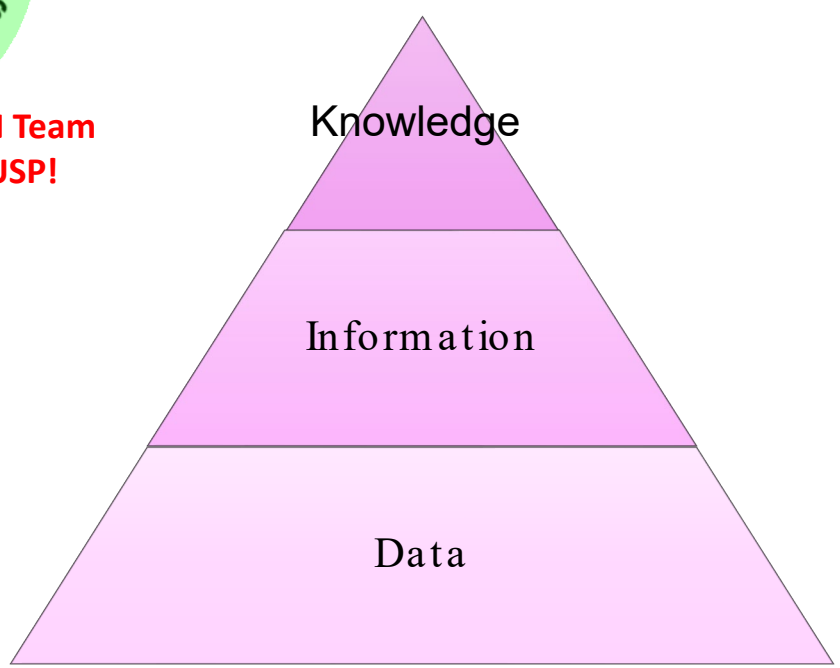
Plus an increasing number of 6G-related collaborations/influence areas….

Data > Information > Knowledge





SLN Team USP!



Intelligence 4G > 5G

Mobile usage, real behaviour, at scale

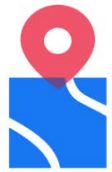
Understand **how People experience the network** in real conditions (News Feed, Videos, Messaging, etc.)

Network performance instrumentation

Calculate key metrics such as **latency, download speed, signal strength/quality** to understand network performance.

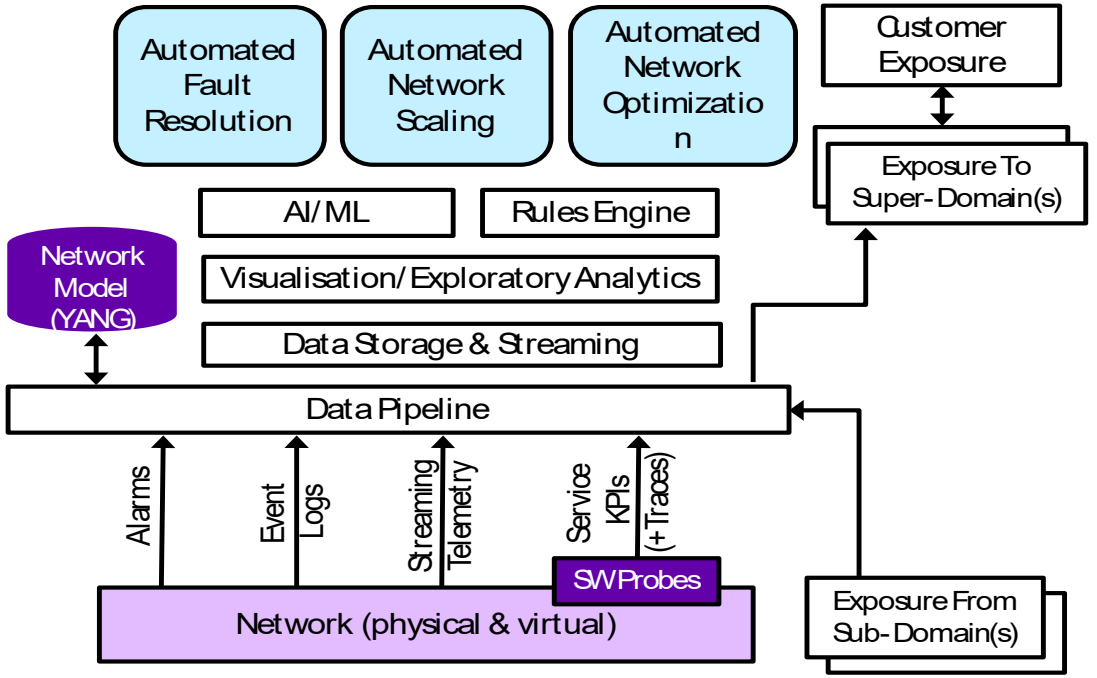
Build cell and site profiles

Aggregate results at the cell level to identify **low quality cells.** Prioritise sites for actions

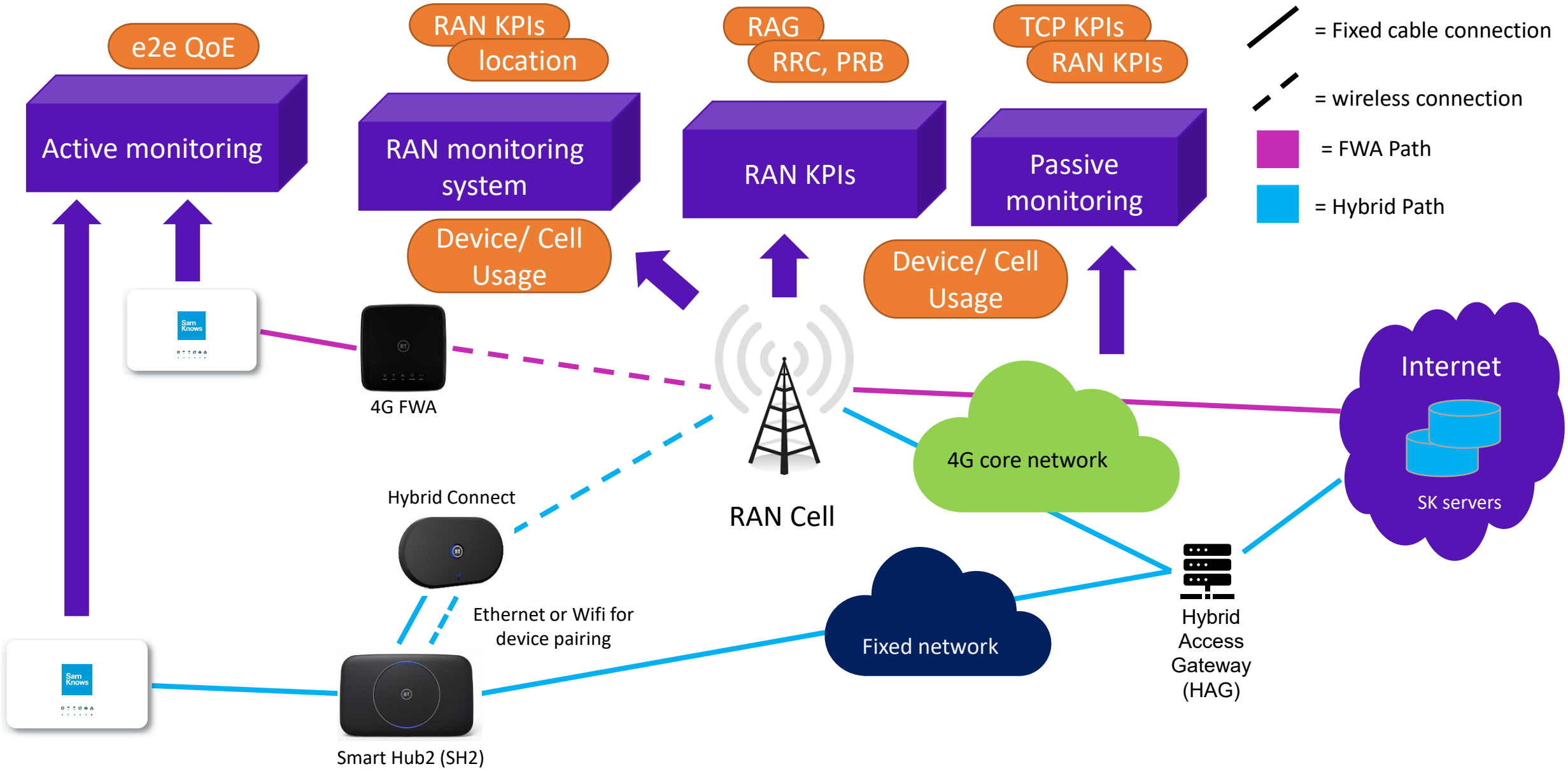


Understand quality at the local level

Aggregate results at the location level to identify areas of opportunity and **benchmark.**

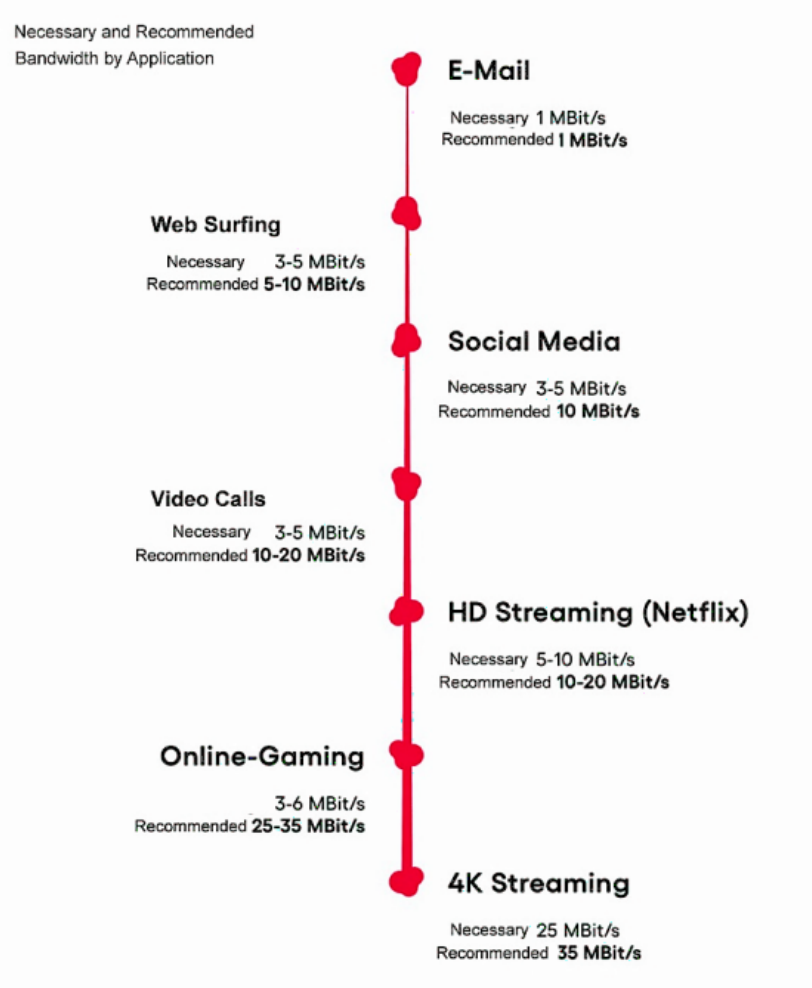


Start looking at current converged network solutions and experiment with any available data



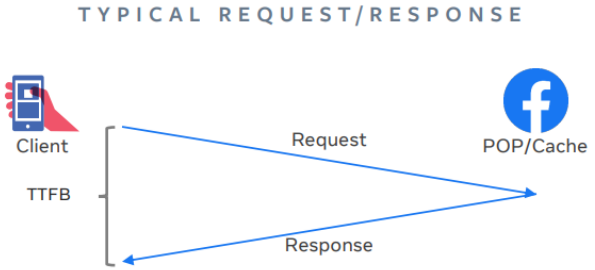
What good looks like?

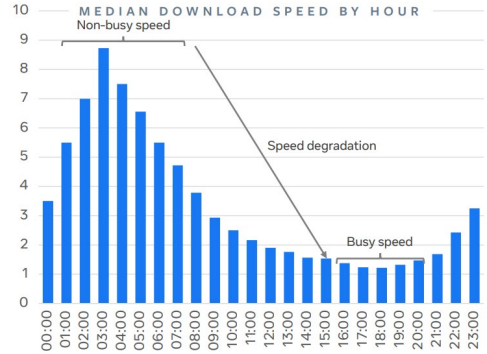
Especially for new Metaverse applications

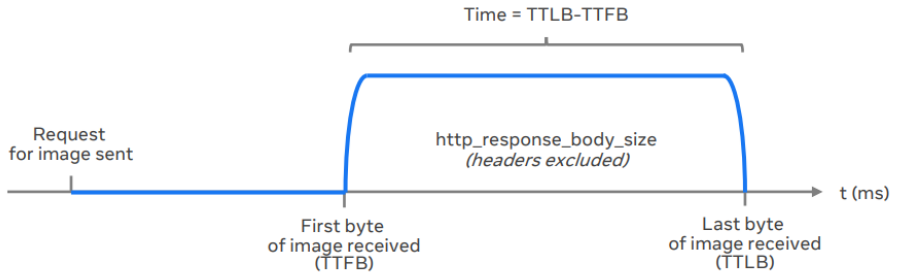


Source: David Clarke, MIT

Source: Meta



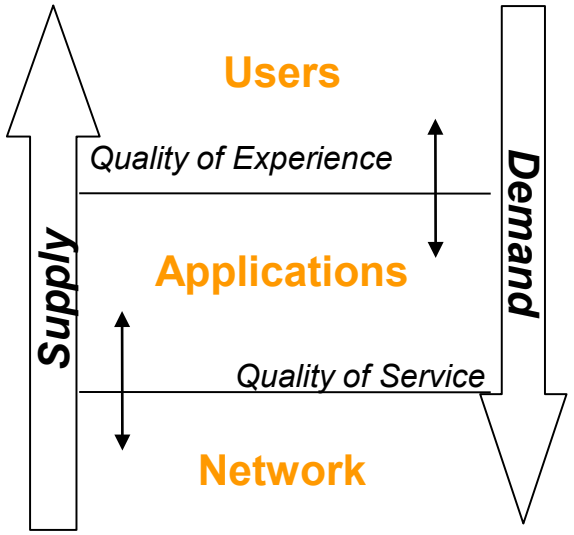




QoE depends on the life of a packet e2e

- **Speed is not everything**
- Interaction between applications and the network is complex & specific to each application
  - Cannot optimise only latency in the expense of packet loss and vice versa
- We need to manage complexity by understanding the overall network behaviour and evaluate performance outcomes

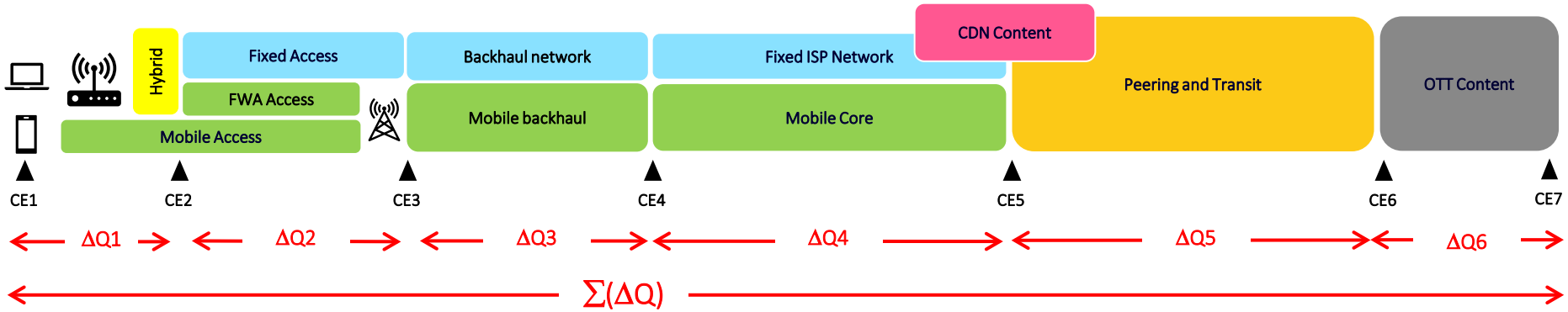
It is not just about Bandwidth, but how packets are delivered e2e



$$QoE = f(\sum \Delta Q)$$

Transport protocol behaviour
TCP or QUIC over UDP

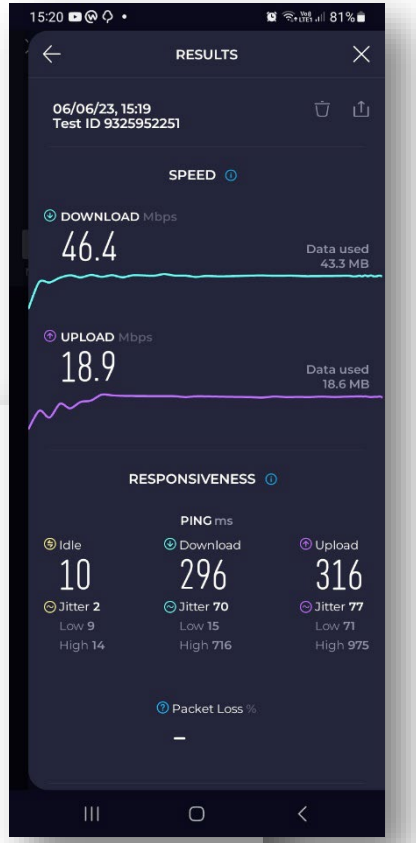
ΔQ: Network Quality Attenuations, ie packet losses, delays and jitter



Towards optimising responsiveness

Domos Understanding Latency Measuring Network Quality in RPM (Roundtrips Per Minute)

Stuart Cheshire, Apple



Measure your Network

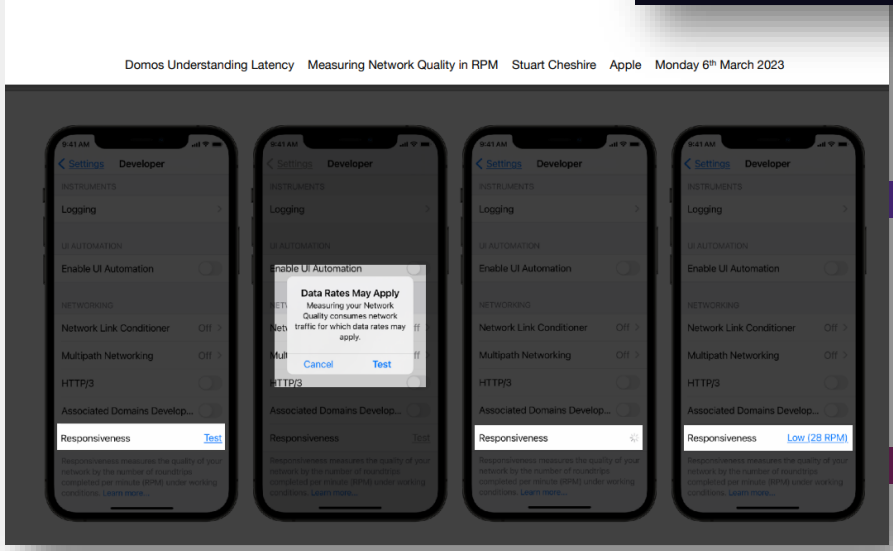
Responsiveness Test in iOS 15 and later

Enable Developer Mode on iPhone

or

Install Wi-Fi debugging profile

- https://support.apple.com/en-us/HT212313

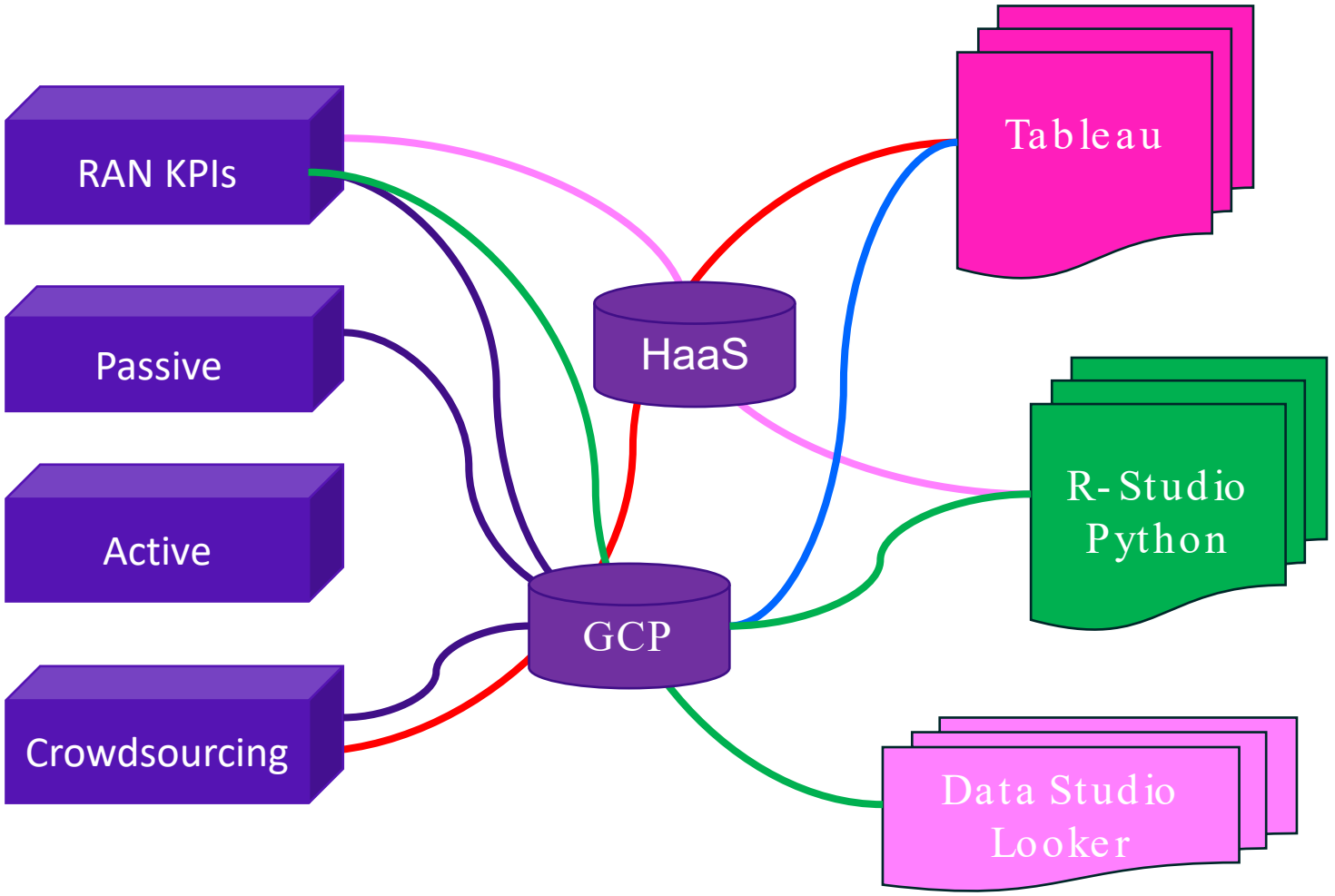


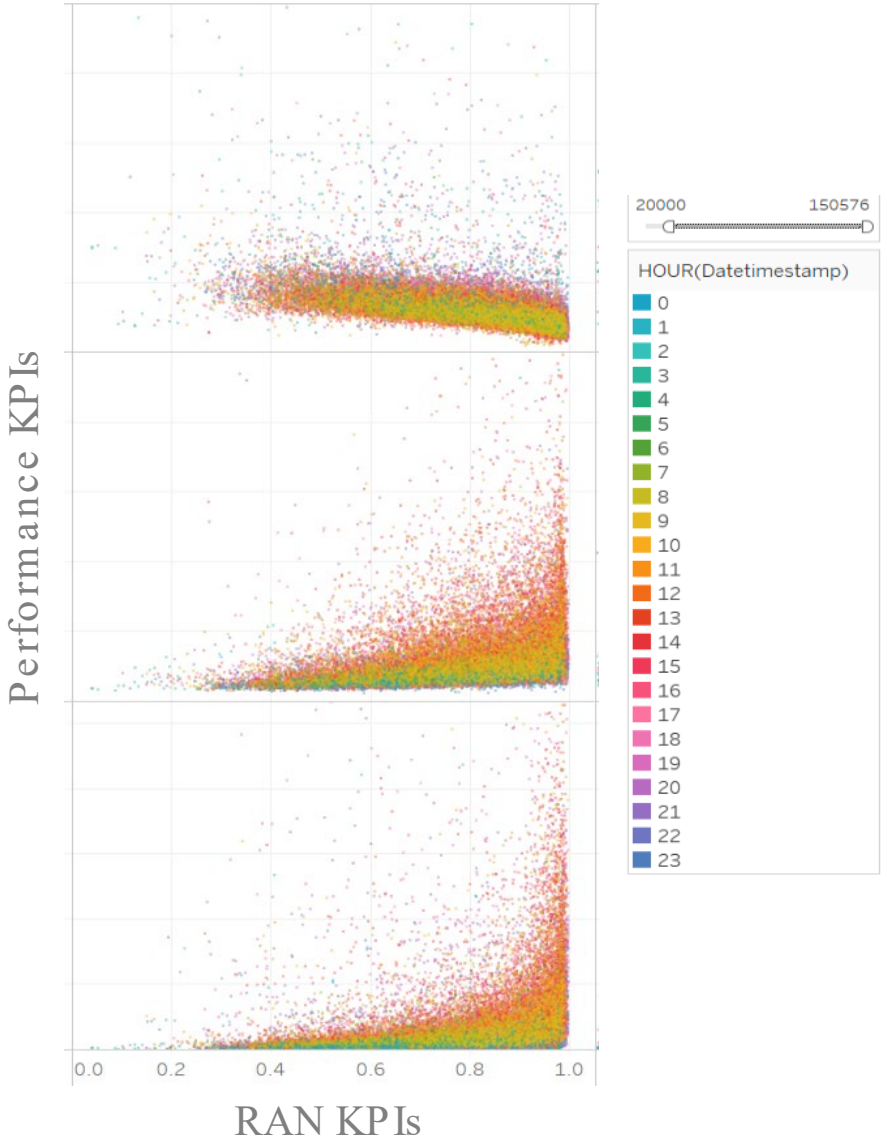
It would take some effort in changing our mindset on how we could differentiate our network performance. It's not going to be achieved by throwing more bandwidth into our propositions but tackling head on why still applications feel sluggish and realising that using only prioritisation between classes of service can't achieve low latency experience e2e.

Solutions that can alleviate Bufferbloat (Bufferbloat.net) have matured and standards bodies like BBF, CableLabs and IETF are providing tools that can be deployed incrementally where our bottlenecks are (e.g. upstream at the CPE or BNG/UPF downstream).

Embrace AQM, L4S, ECN!

Data Sources and Tools



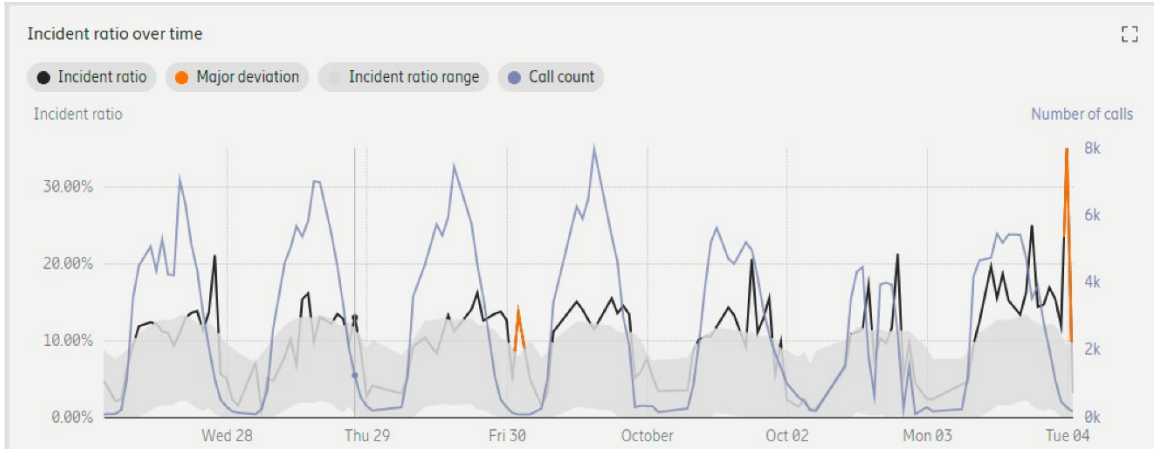


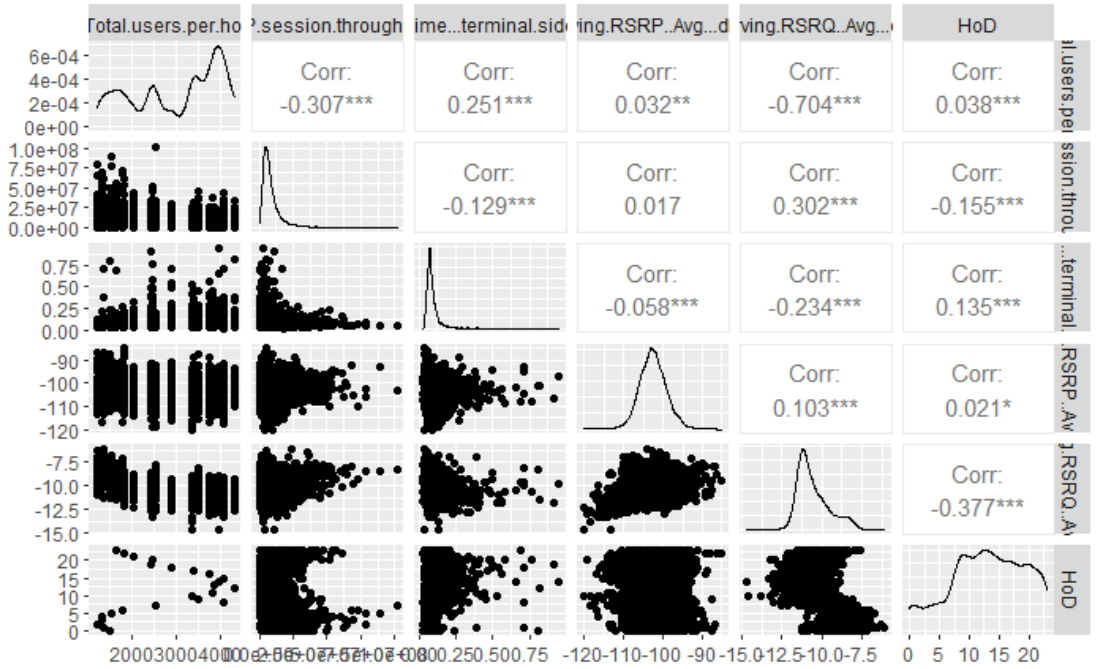
Let your data scientists loose!

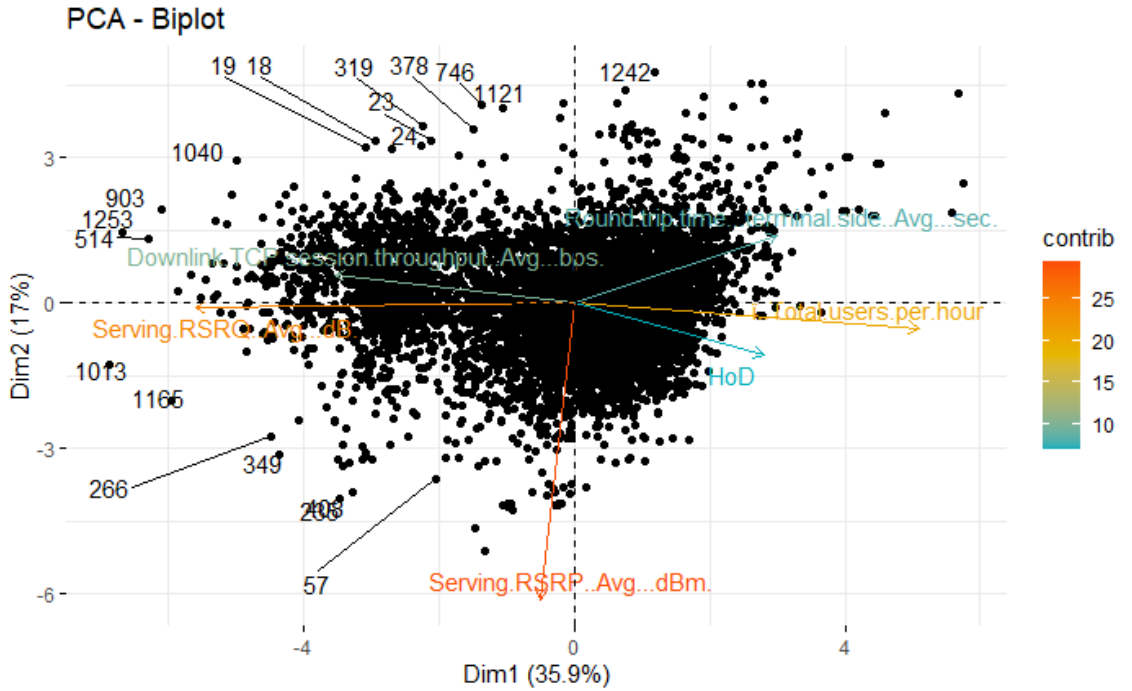
Anomaly detection

Time series archetypes

Principal component analysis







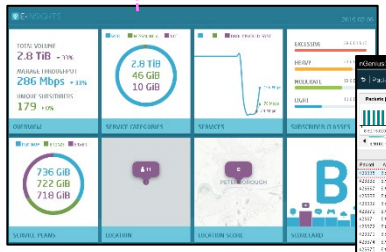
BT Research project : Instrumentation in Virtualised Environment (led by Paul Veitch)

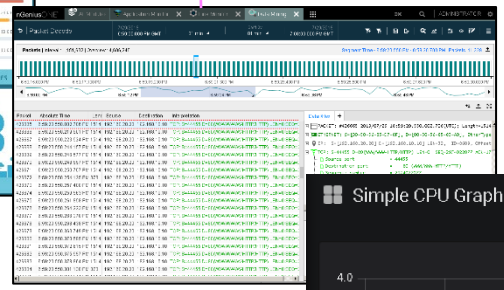
+ End-to-end Intelligence, Orchestration, Data Management, Insights Analysis, M

Many vendors of VTAs/vProbes also have stand-alone analytics platforms and solutions

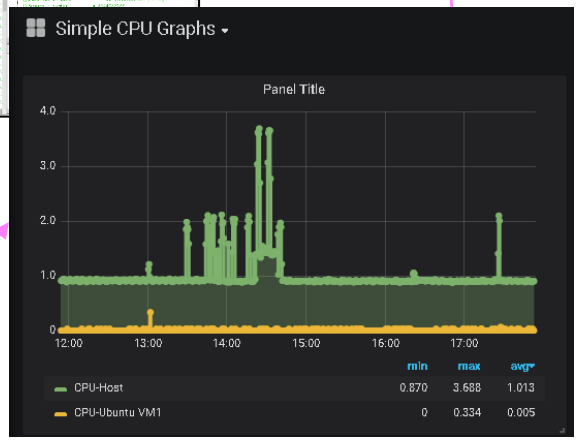
VTA End-to-end report

VTA Single VNF report





vProbe Monitoring and Reporting



Grafana showing CPU utilisation for host server plus VM

Virtual Test Agents (VTAs) can be setup to test a monitor e.g. Inter-VNF (end-to-end, or SFC "sections" measurements & insights are based on actual te traffic sent between VTA interfaces.

Virtual Probes (vProbes) can be setup at suitable tap points to "see" current traffic, and generate repo on usage, KPIs, etc: measurements & insights b on actual user-plane traffic .

ACTIVE

PASSIVE

VTA

VNF1

VNF2

Having VTA instances on distinct servers allows us to test "inter-node".

VTA

vProbe

VNF3

VNF4

EgEdge Compute

x86 server + hypervisor

EgCore NFV

collectd

x86 server + hypervisor

Grafana
Influxdb

Works in conjunction with dB (e.g. influxdb) & visualisation/graphing tool (e.g. Grafana)

"Platform-level" Monitoring Telemetry, e.g. collectd Various plugins can be enabled to monitor the base infrastructure hosting the VNFs: CPU, memory, OVS, DPDK, etc.

Installed and run as process daemon on host OS assuming open-source/Linux-KVM-based

07/06/2023

Key messages

- Ongoing Research projects try to rationalise 5G Assurance & Observability
- **Data turned into insights & knowledge** is a fascinating area and requires the active collaboration between subject matter experts and data scientists
- **New unified tools** can help us become more confident in processing and analysing our data
- Be prepared to explain performance changes when roaming between different access technologies or when traffic steering takes place (think ATSSS)
- Need to define blueprints of **QoE requirements for new immersive and interactive applications**
- A combination of monitoring techniques would complement each other by offering a different vantage point of view and allow for **holistic forensics**
- Be prepared to **validate SLAs in different domains** &be accountable (major challenge!)
- Prepare to embrace a **'quality delivered' framework** rather than throwing more bandwidth into the problem
- Consider the additional complexity of **cloud native infrastructure** and be able to distinguish compute layer performance issues affecting networking performance

Thank you!