University of ULSTER IU-ATC India-UK Advanced Technology Centre of Excellence in Next Generation Networks, Systems and Services

Measurement-Based Policy-Driven QoS Management in Converged Networks

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Outline IU-ATC India-UK Advanced Technology Centre of Excellence in Next Generation Networks, Systems and Services

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- **Rationale for CNQF (Converged Networks QoS Management Framework)**
- **Components of CNQF Architecture**
- **Testbed implementation at Ulster, UK**
- **CNQF Prototype implementation**
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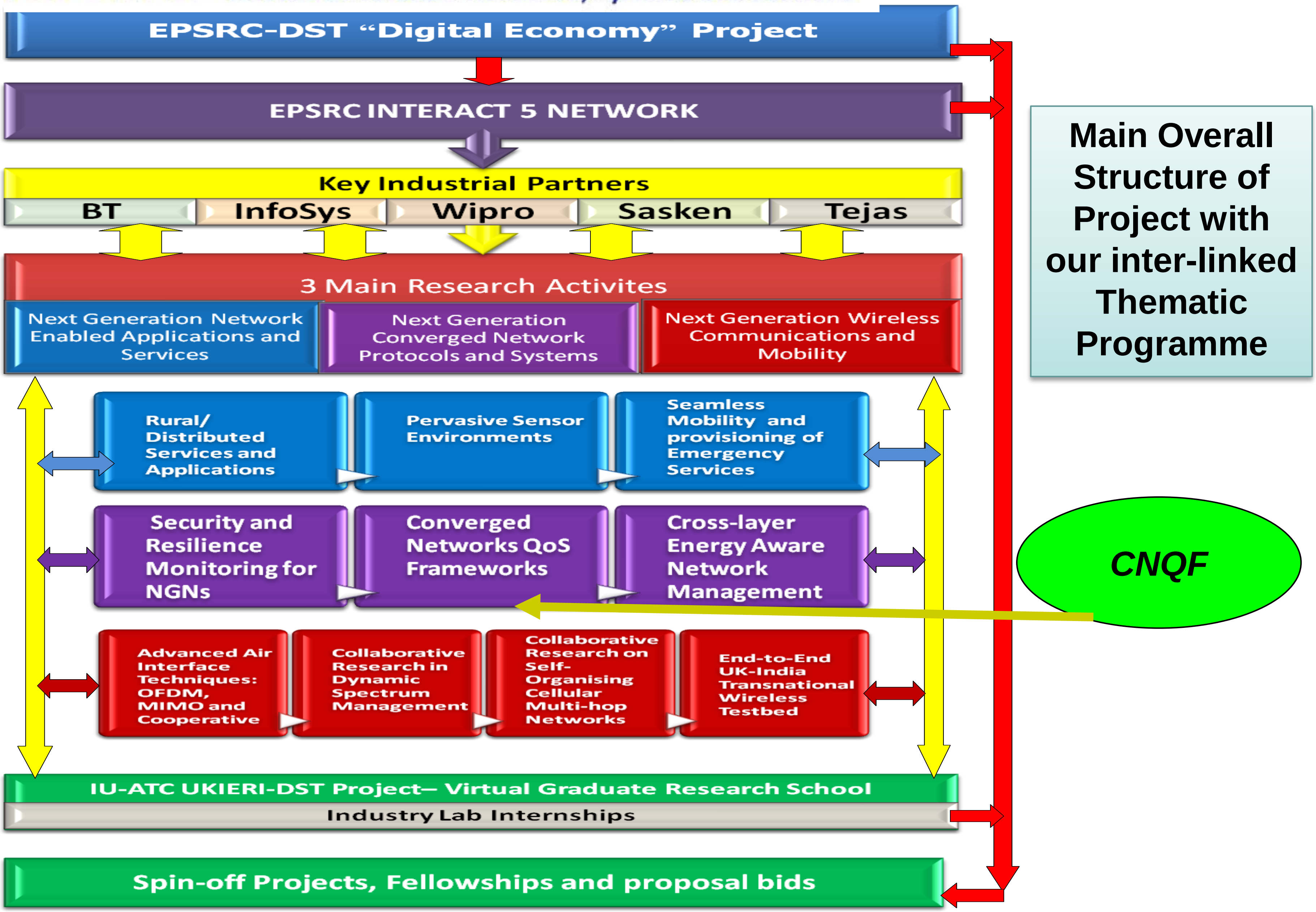


Introduction/Motivation for CNQF

- **Fixed and Wireless access technologies such as WiMAX, Cellular, PONs, 4G/LTE, xDSL, are increasingly converging towards common IP-based transport in Next Generation Networks.**
- **Convergence calls for *unified end-to-end QoS management* in order to achieve efficient service provision.**
- **To this end, a *policy-based* QoS management framework CNQF is proposed.**
- **The framework architecture of *CNQF (Converged Networks QoS Management Framework) addresses the integration of heterogeneous QoS mechanisms through policy based network management (PBNM) paradigm.***
- **The need for *unified management and control plane* functionalities to co-ordinate end-to-end transport in converged networks motivates use of PBNM.**
- **PBNM allows for automated *configuration and control* of the network as as whole eliminating the need to configure and manage multiple heterogeneous individual management entities.**

Converged Networks' QoS Management Framework (CNQF)

- ***CNQF is a PBNM framework designed to provide homogeneous, unified, end-to-end QoS management over heterogeneous access technologies, together with scalable, adaptive context-aware QoS control.***
- **Consists of distributed functional entities coordinating resources of the transport network for automated QoS control via centralized policies.**
- **CNQF architecture is aligned with IETF/TISPAN/3GPP PBNM paradigms.**
- **Layered and hierarchical architecture.**

CNQF subsystems

Three logical subsystems providing policy-based infrastructure for *closed-loop, scalable, and homogeneous QoS management*:

- ***Resource Management Subsystem (RMS):***
  - **Resource Brokers: Wireless Access (WARB), Fixed Access (FARB) and Core Network (CNRB).**
  - **Resource Controllers (RC) .**
- ***Measurement and Monitoring Subsystem (MMS):***
  - **Distributed Network Monitors (NM).**
  - **Central Measurement and Monitoring (CMM).**
- ***Context Management and Adaptation Subsystem (CAS):***
  - **Context Acquisition Functions (CAFs).**
  - **Adaptation Servers (ADS).**

CNQF architecture

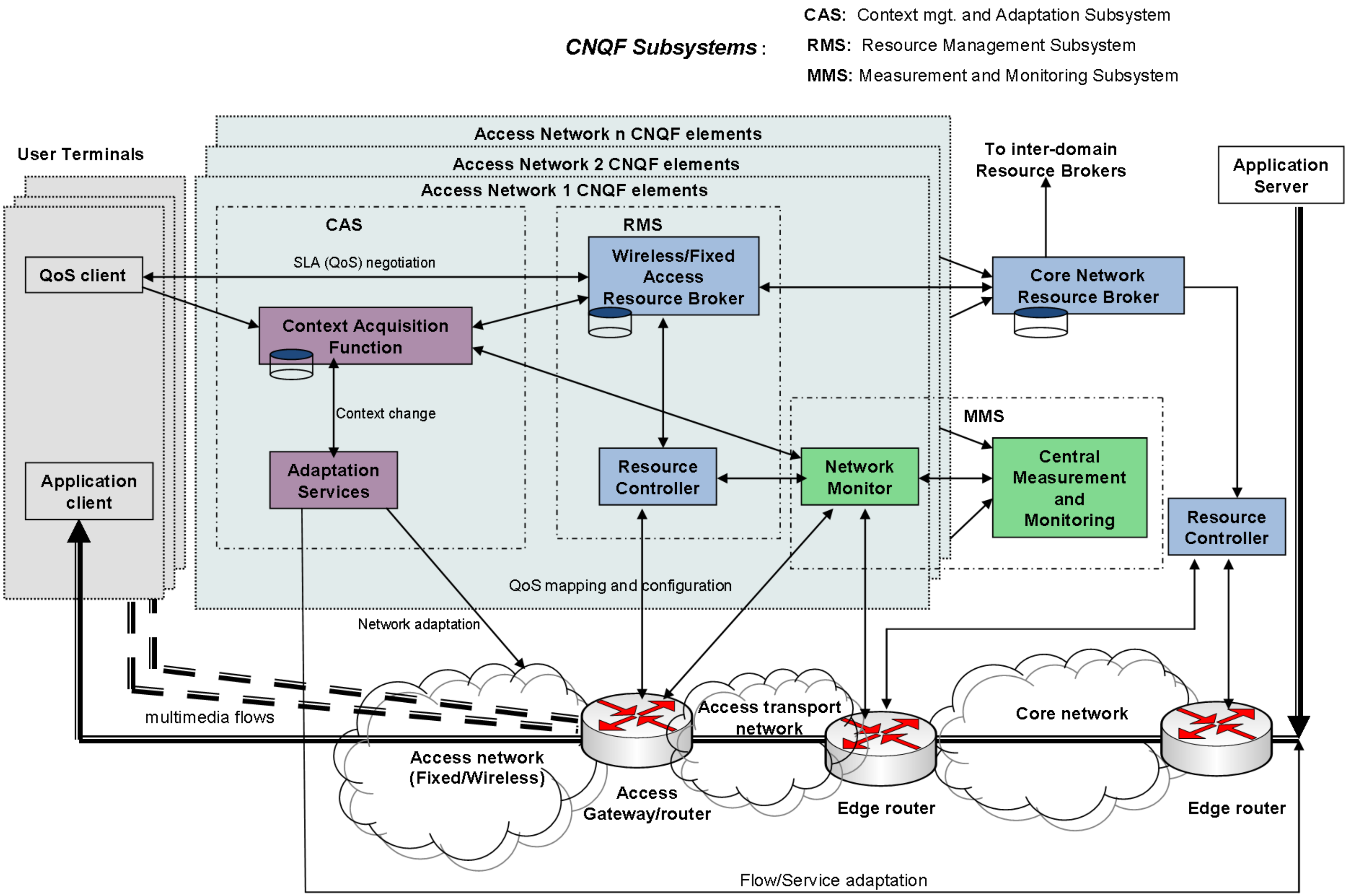


Fig. 1: CNQF architecture

CNQF layers

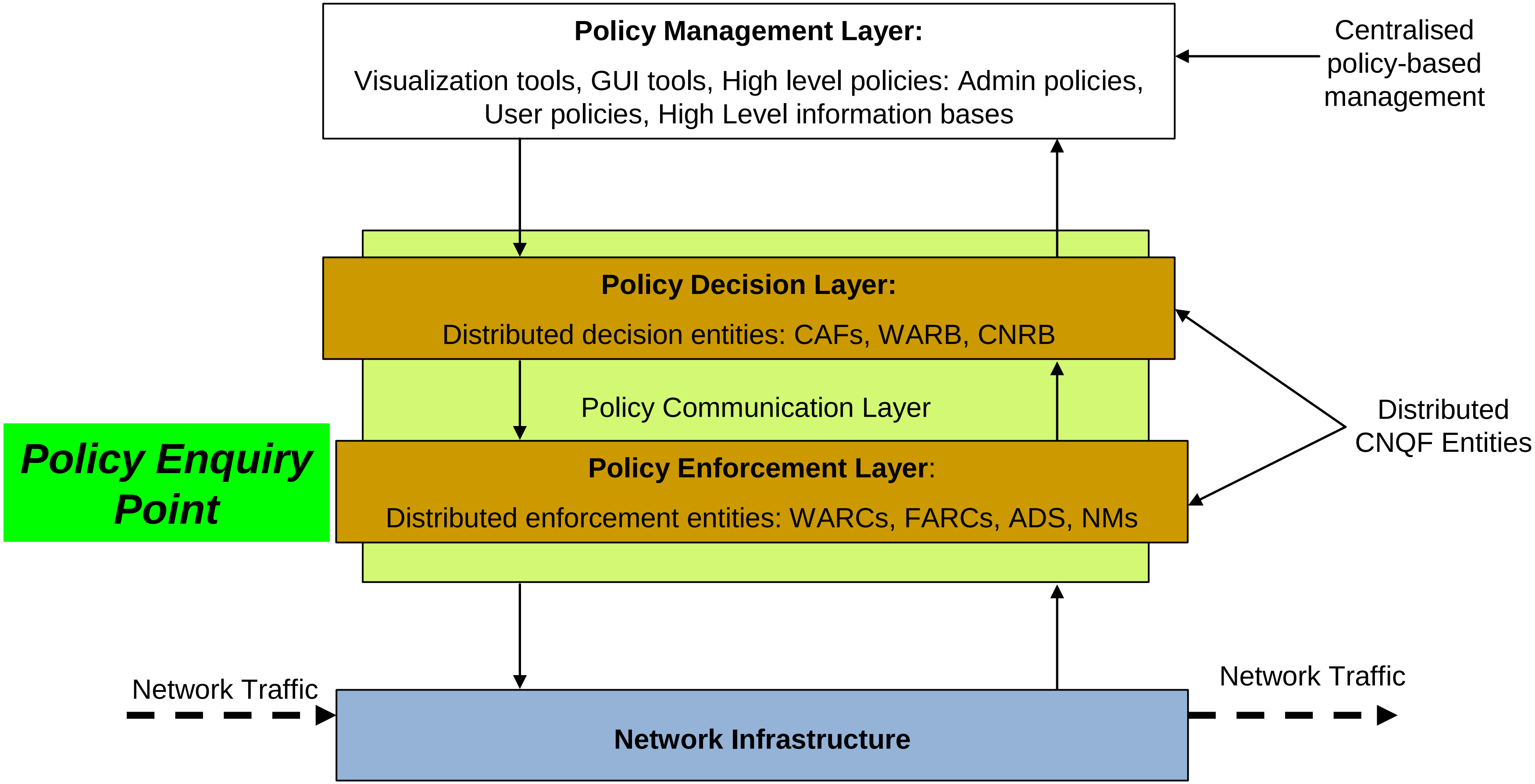


Fig. 2: CNQF layers

Testbed and prototype implementation

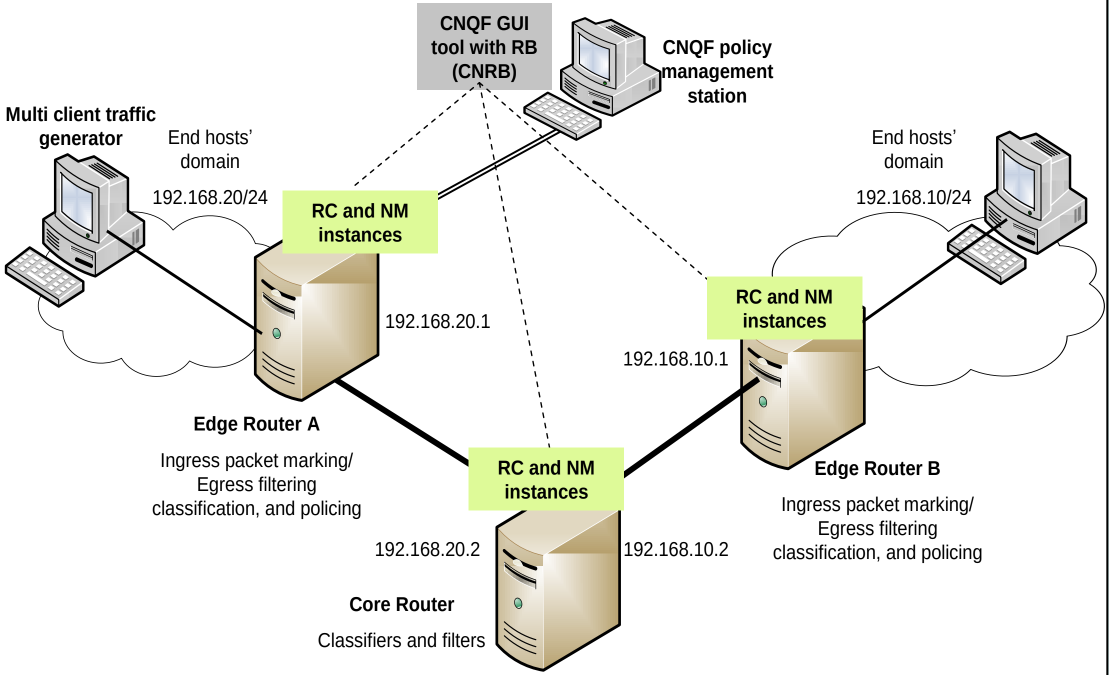


Fig. 3: Distributed CNQF elements on IU-ATC NETCOM testbed

- **Development of a CNQF prototype for use case evaluation and proof of concept demonstrators is ongoing.**
- **To facilitate prototype development a testbed is also being developed with Linux and open source utilities.**
- **The testbed provides the transport plane functionality and QoS mechanisms for deploying and evaluating the CNQF PBNM system using real traffic flows.**

- **Linux-based core router & edge routers (Policy enforcement Points)**
- **Instances of CNQF Resource Controller interact with the kernel to set parameters that enable QoS management strategies driven by Resource Broker high-level policies.**
- **CNQF Resource Controller interacts with Linux TC utility to implement: packet marking, classification, queuing disciplines, policing etc. through high level policies**

Prototype implementation

- Prototype based on CNQF architecture:
  - Distributed Resource Controller elements being implemented in Java (ResCon class)
  - Distributed Network Monitoring elements being implemented in Java (NetMon class)
  - Resource Broker is housed in CNQF management station and communicates with remote Resource Controllers installed on the Policy Enquiry Points (PEPs)
  - Central Measurement and Monitoring element is housed in CNQF management station communicates with remote network monitors installed on the PEPs

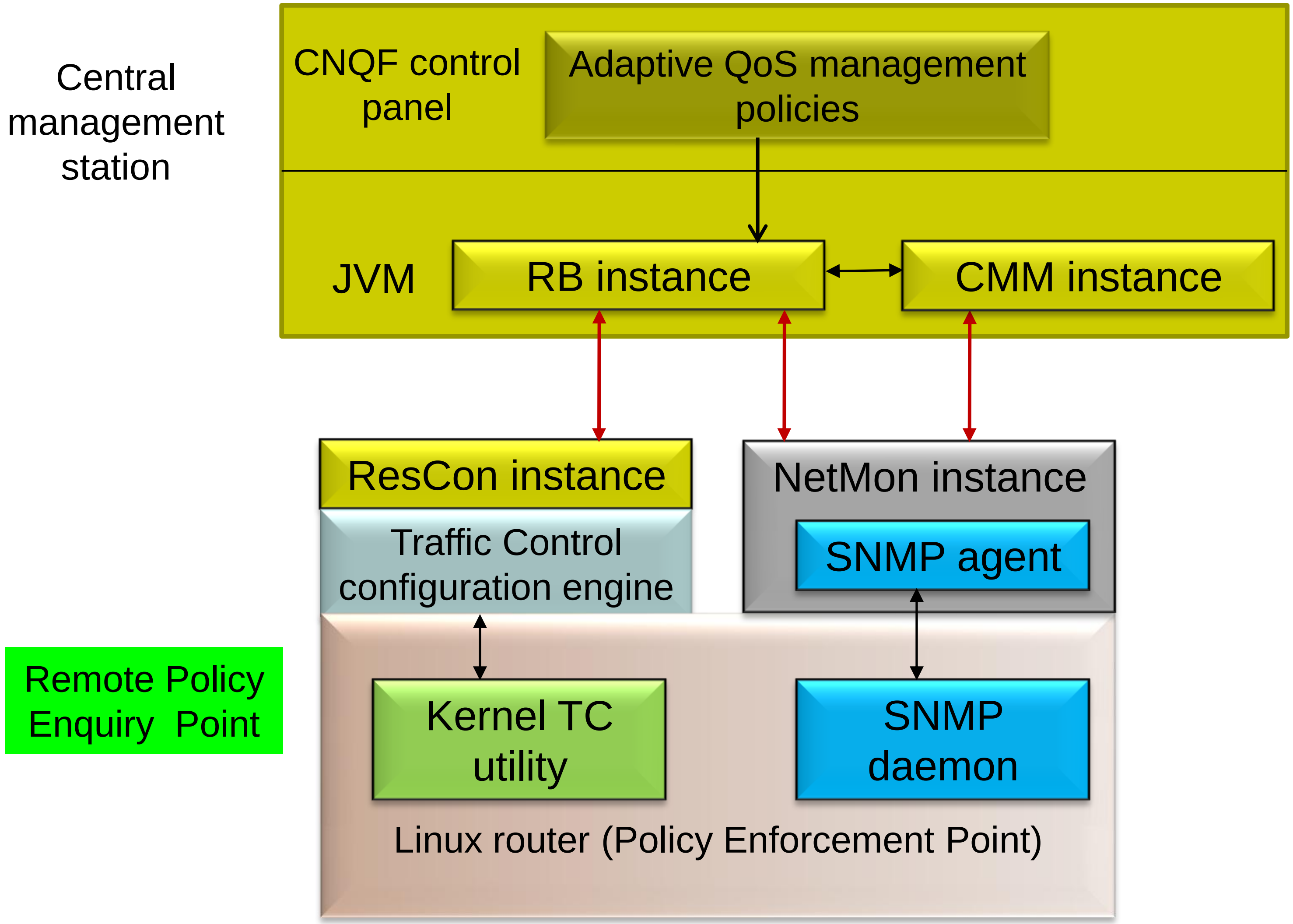


Fig. 4: Current prototype implementation architecture

MIB object	description	OID
ifInOctets	The total number of octets received on the interface, including framing characters	1.3.6.1.2.1.2.2.1.10.2
ifOutOctets	The total number of octets transmitted out of the interface, including framing characters	1.3.6.1.2.1.2.2.1.16.1
ifSpeed	An estimate of the interface's current bandwidth in bits/sec	1.3.6.1.2.1.2.2.1.5.1

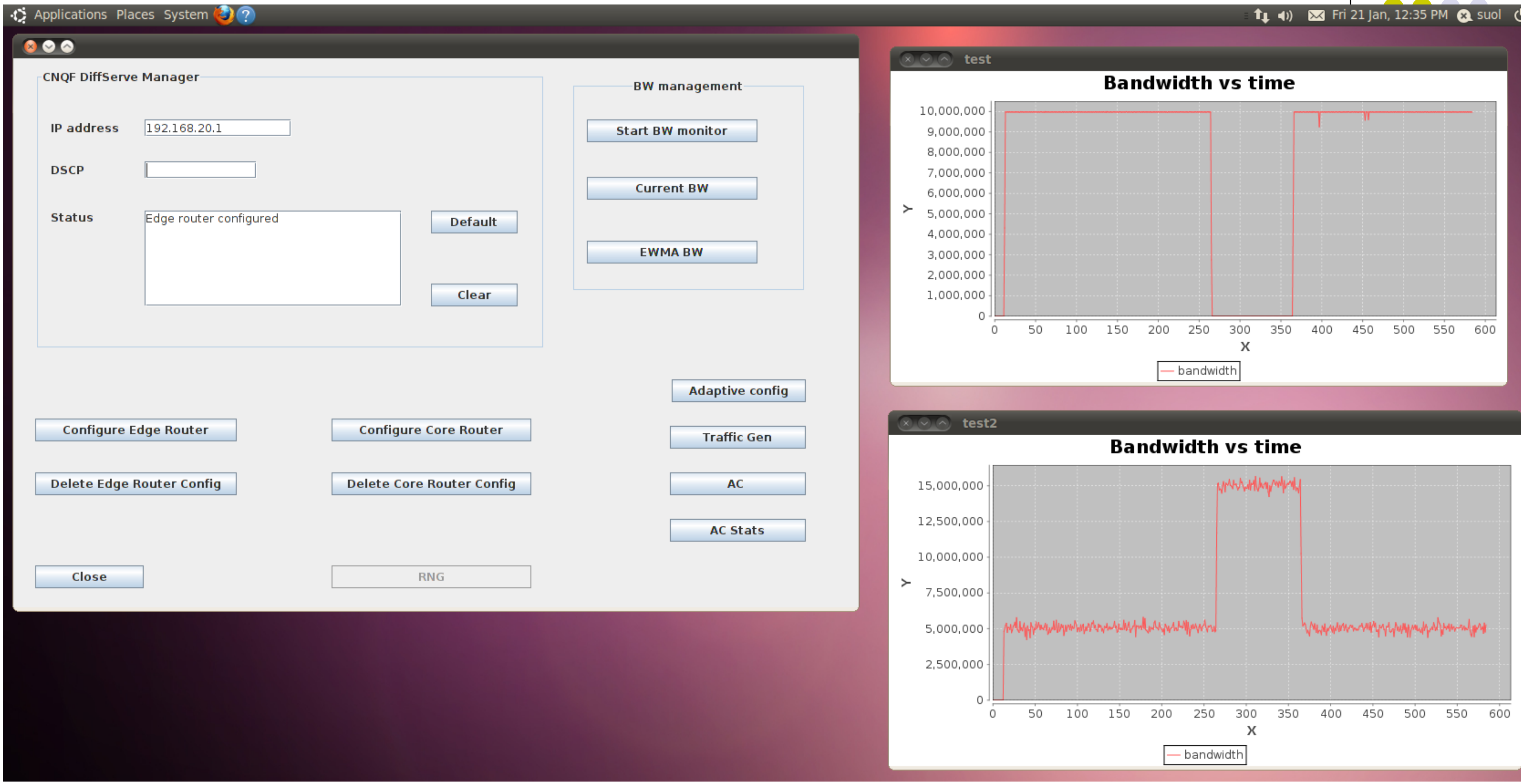
BW (bits/s) = O(t) – O(t-Δt) *8/ Δt-------------------------------(1)

BWU (%) = O(t) – O(t-Δt) *8*100/ Δt * ifSpeed---------------(2)

BW(t) = (1-α) * BW (t- Δt) + α* BW(t) -------------------------(3)

NetMon SNMP MIBs for bandwidth monitoring

Testing CNQF management control interface with NetMon statistics capture on live NETCOM testbed



- •QoS configuration via remote ResCon instances initiated from CNQF control panel
- •traffic monitoring for EF (graph 1) and BE (graph 2) flows via remote NetMon instances

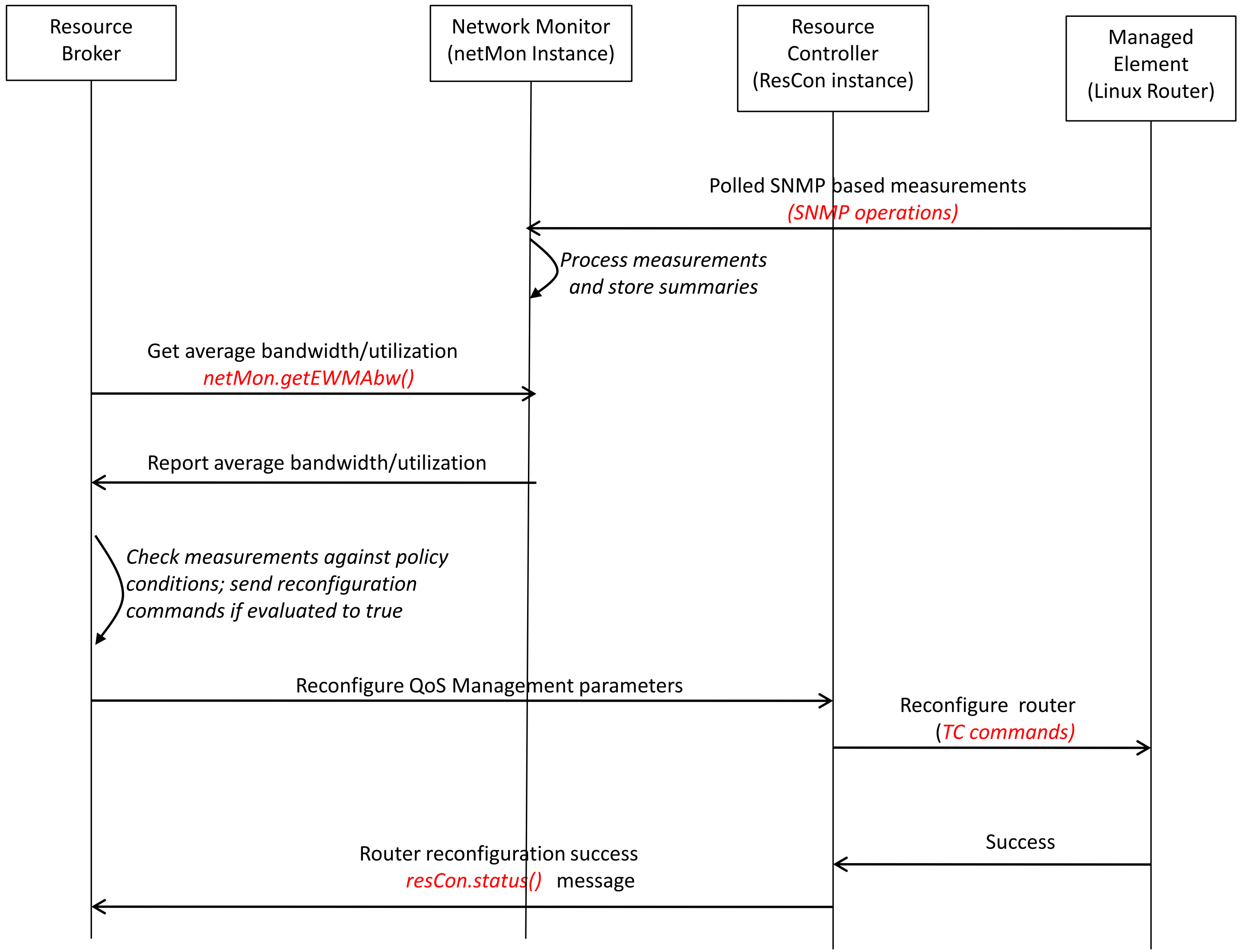


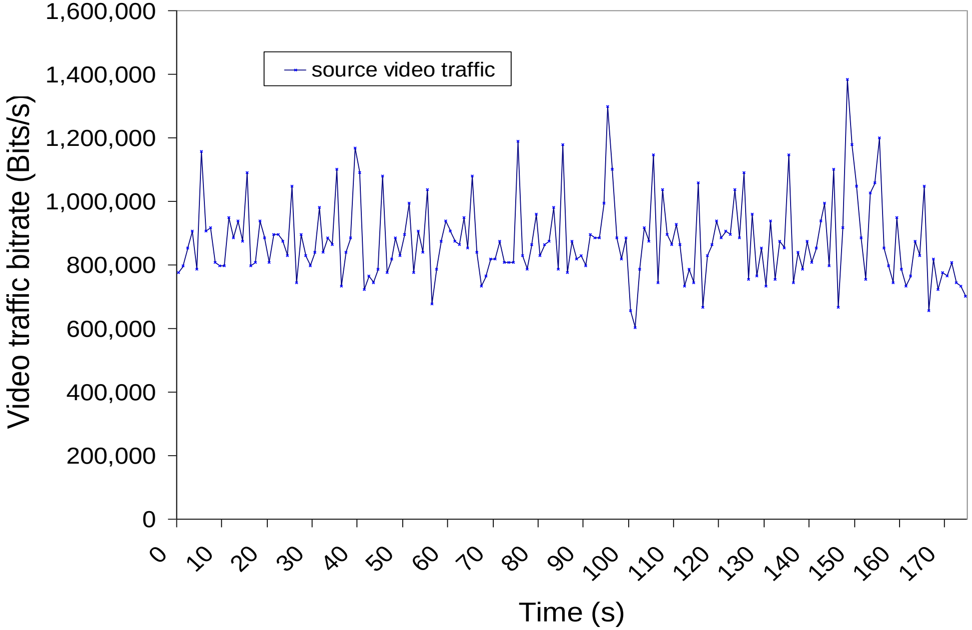
Fig. 6: Message exchange sequence between CNQF prototype entities

POC validation: CNQF-enabled QoS management configuration

- **Objective:**
  - **To achieve remote QoS configuration of PEPs to enable packet marking, classification and priority queuing for DiffServe QoS management via CNQF**
  - **To observe the effect on real traffic flows' QoS**

- **Traffic flow parameters**
  - **Flow 1: MPEG video (1Mbps VBR video stream)**
  - **Flow 2: 1Mbps CBR flow**
  - **Flows 3-20: VBR flow Exponentially distributed IITs: 0.2ms Packet size: 1518 bytes (generated from *ntools* traffic generator).**
  - **Flows 21-30: ON-OFF flows ON:3s 5ms exponentially distributed IIT, 1518 bytes, OFF: 3s (generated from *ntools* traffic generator).**

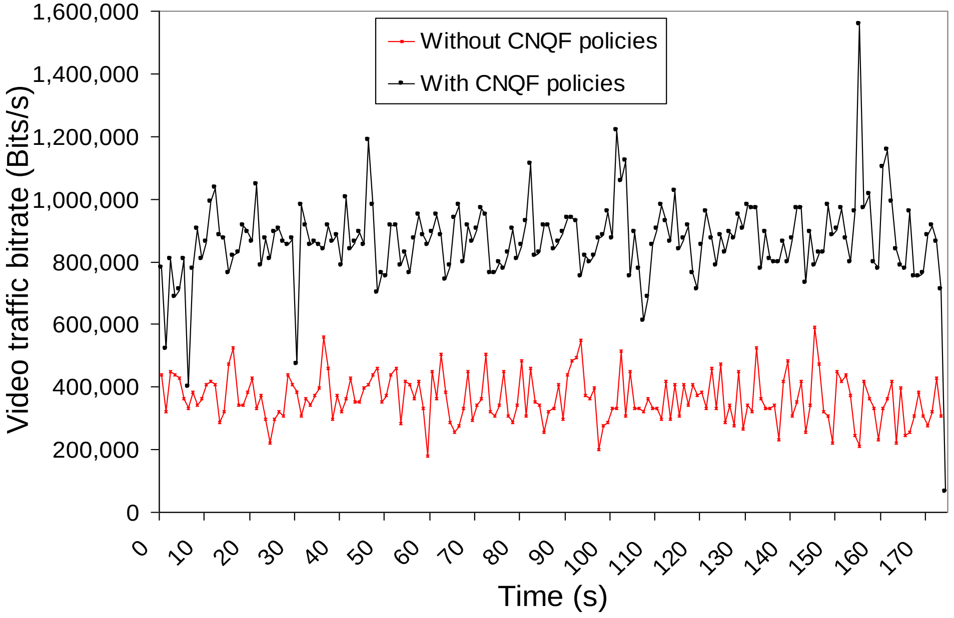
Impact of CNQF based management on video traffic



Measurements of MPEG video traffic at source ingress router

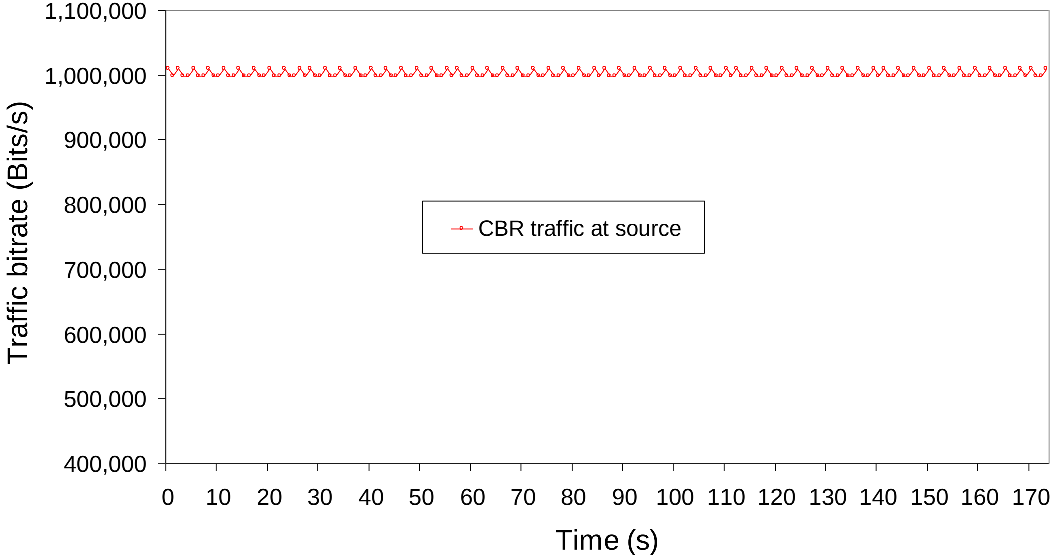
Key distinction is allowed best effort or CNQF QoS Preferences

Note: this is real traffic



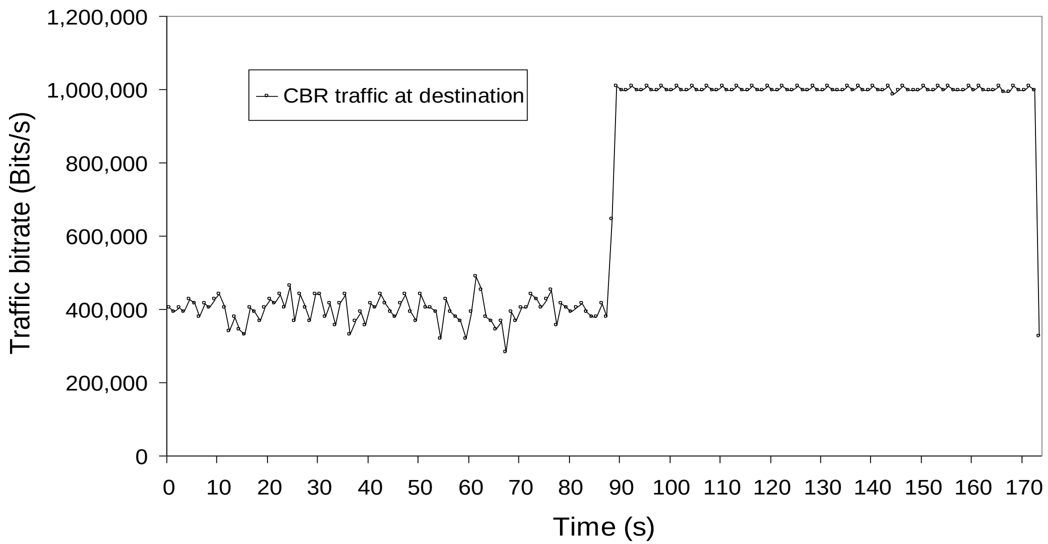
Measurements at destination egress router (a)with, (b) without CNQF management

Impact of CNQF based management on CBR traffic performance



Measurements of real CBR traffic at source ingress router

Traffic is from utility traffic generator injected into testbed. Expedited Forwarding- Differentiated Services Code Points are used- EF-DSCP



Measurements at destination egress router (a)without (b) with CNQF management activated at 90s

Further work

- Enhancing passive measurement mechanisms of CNQF MMS.
- Implementing active measurement mechanisms in CNQF MMS.
- Policy Management Tool integration with CNQF entities (e.g. ponder, pondertalk).
- Designing and implementing CNQF PDP decision algorithms.
- Implementing CMS elements.
- Expanding current Markov-based CNQF model to support further scenarios POC validation
- Extension of testbed with wireless access/emulators and WiMAX-EPONs demonstrators that exist within Ulster and also the IU-ATC partners at IIT Madras, University of Surrey (UK), University of Lancaster(UK) and University of St Andrews (Scotland). Links with BT Optical testbeds are under investigation.
- Interaction with IETF and ITU on Standards Development

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- **Thank You**

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