

QoE optimization with network layer awareness on hybrid wireless network

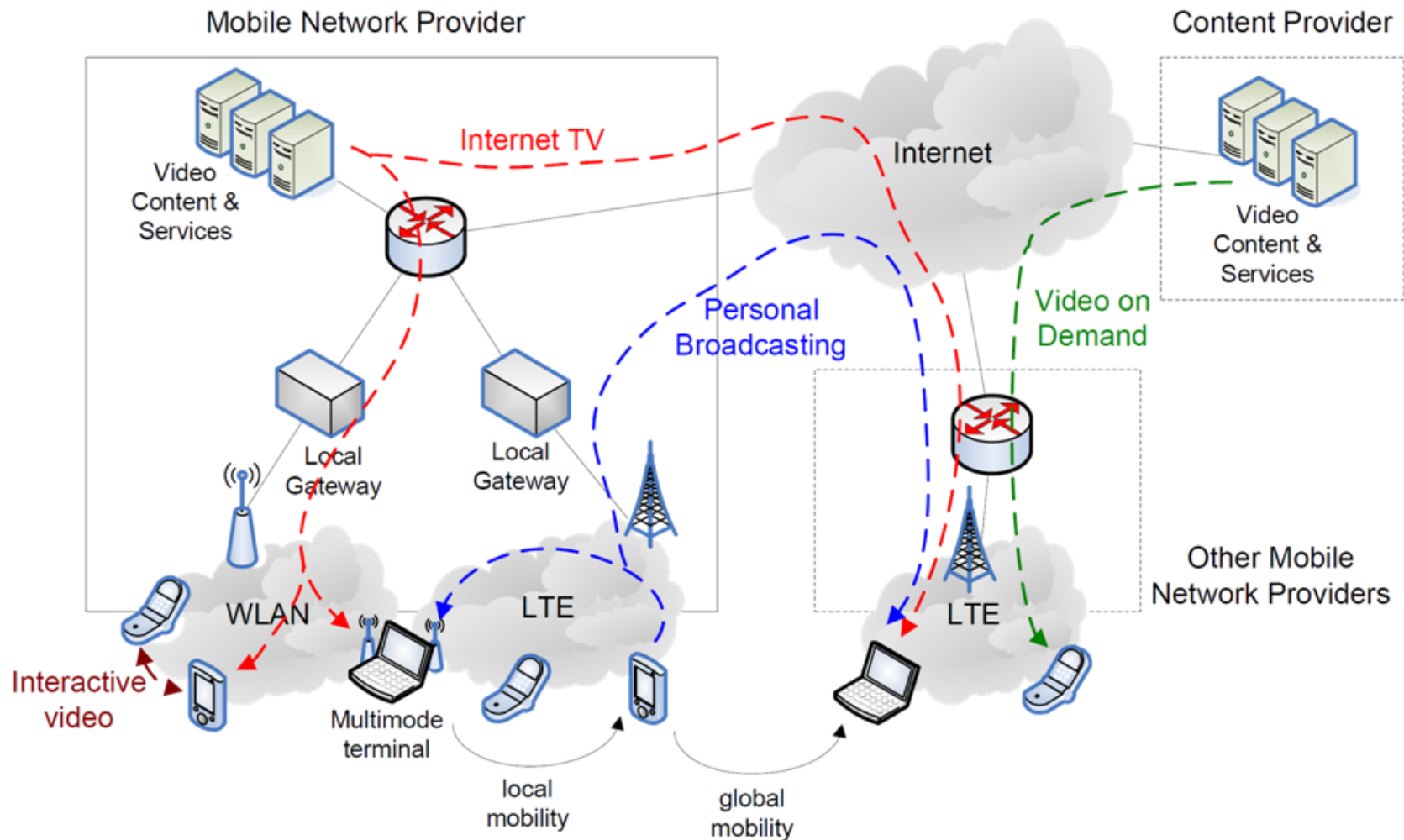
T. Melia, S. Randriamasy

Alcatel-Lucent Bell Labs, FRA

***D. Munaretto**, M. Zorzi*

CFR – University of Padova, ITA

Scenario in Medieval



Motivation

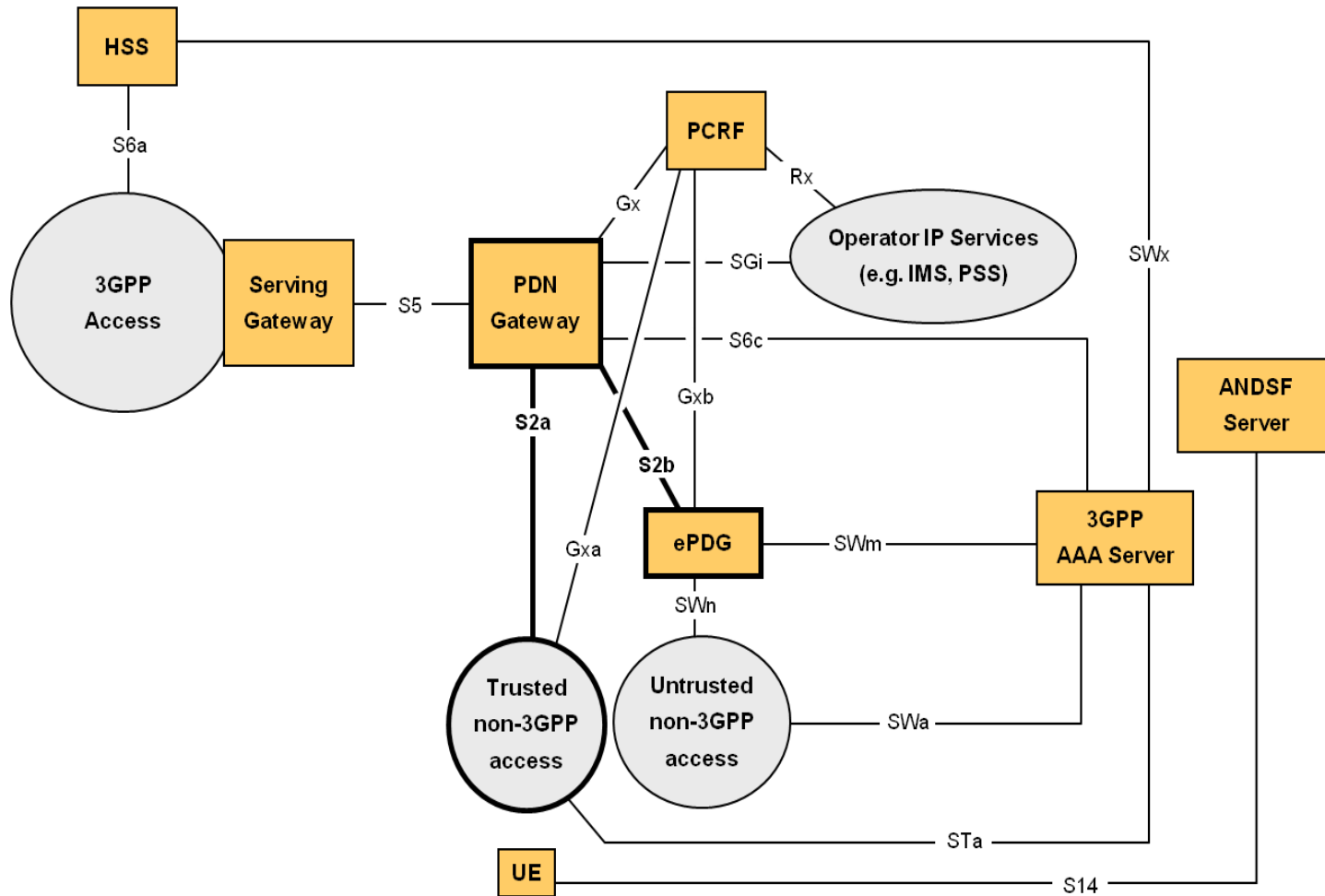
NOW: Ubiquitous wireless access is a reality

- ✓ Smartphones integrating cellular and Wi-Fi technologies -> gaining a large market share
- ✓ access to data stored anytime and anywhere

TARGET: new business opportunities for converged services offered across available access networks

- ✓ WiFi offload, multi PDN connections and IP flow mobility as key tools to steer IP traffic depending on users' profiles, operators' policies and network conditions

Motivation



ANDSF: Access Network Discovery & Selection Function: to assist UE to discover non 3GPP access

Motivation

CHALLENGE: application storm

✓ Mobile operators facing the challenge of supporting application storm and require new tools to better control their resources while keeping the customer satisfaction, reducing churn rate

SOLUTION: Design of a framework starting from 2 key issues:

1. quality perceived by the end users (QoE-oriented redesign of networking mechanisms) anytime and anywhere
2. application requirements in terms of network resource usage

Motivation

CHALLENGE: application storm

✓ Mobile operators facing the challenge of supporting application storm and require new tools to better control their resources while keeping the customer satisfaction, reducing churn rate

SOLUTION: Design of a framework starting from 2 key issues:

- 1. quality perceived by the end users (QoE-oriented redesign of networking mechanisms) anytime and anywhere**
2. application requirements in terms of network resource usage

1) Video Quality

KEY IDEA: new ways to meet customer satisfaction and to steer IP traffic across wireless access networks, possibly in quasi-real time

SOTA:

- ✓ **Full-reference** metrics: computationally light (e.g., MSE-PSNR), comparison reference vs. received videos -> restricted w.r.t. practical usability -> suitable for off-line apps
- ✓ **No-reference** metrics: analyzing received videos, more flexible, assumptions on video content and distortions -> more appealing for real-time, but at the cost of higher computational efforts

CHALLENGE: Video application served through different paths results in different QoE -> mobile operator in charge of guiding the service to keep target QoE and to optimize network resource usage

Motivation

SOLUTION: Design of a framework starting from 2 key issues:

1. quality perceived by the end users (QoE-oriented redesign of networking mechanisms) anytime and anywhere
2. **application requirements in terms of network resource usage**

2) Network resource usage

KEY IDEAS: applications requirements in terms of network resources

- ✓ diversification of wireless access technologies to address application requirements in different ways
- ✓ different QoE over different paths with possibility for user to choose best available QoE

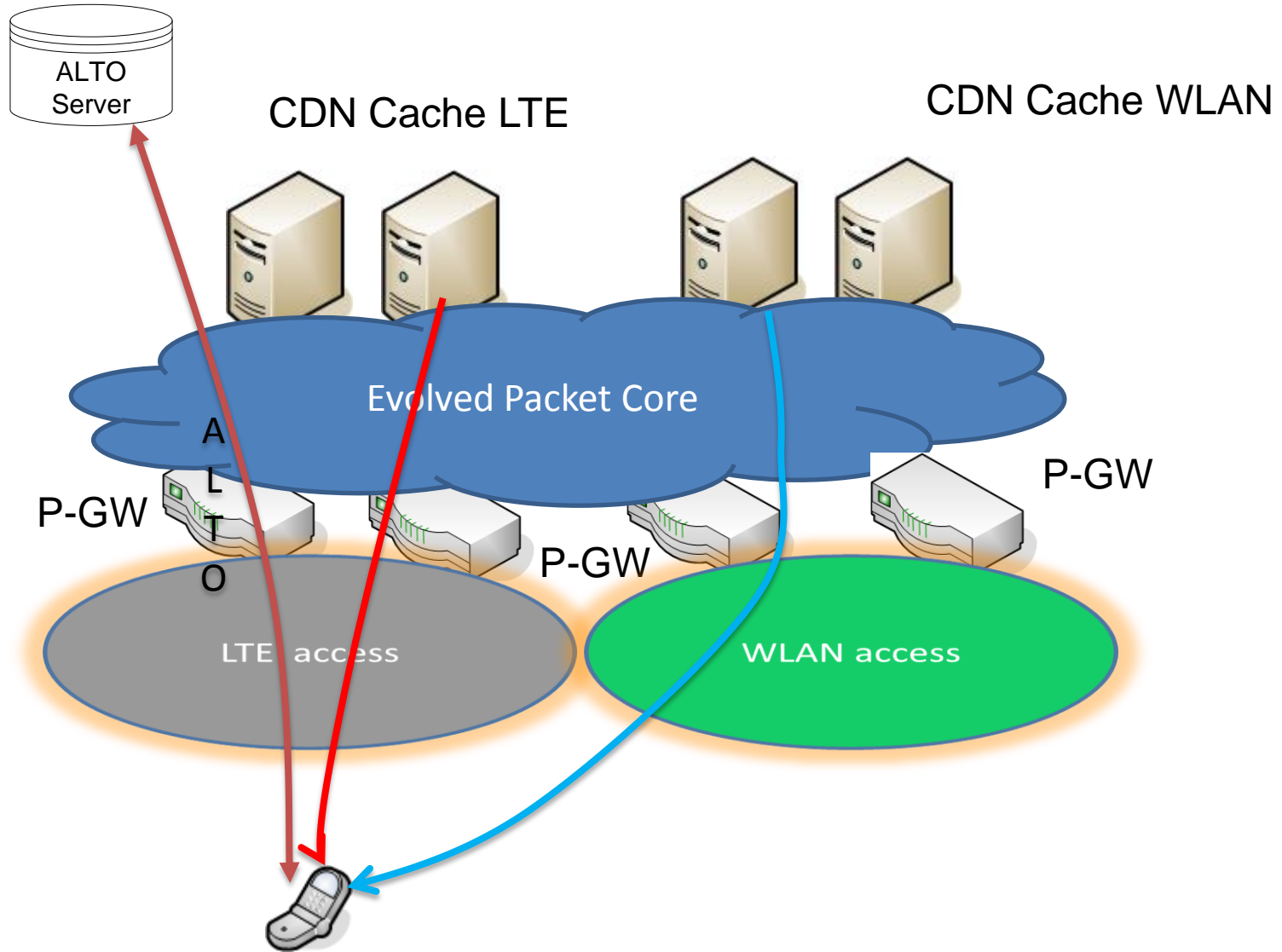
TARGET: operator needs a tool to provide network costs associated to different paths and guide apps to better optimize network resources

SOLUTION: tool being defined by IETF Working Group ALTO (Application Layer Traffic Optimization)

ALTO functionalities

- Guidance to content based applications (P2P, CDN), to select one or several hosts or endpoints from a set of candidates able to provide the data
 - Guidance based on parameters that affect performance and efficiency of the data transmission between hosts, e.g., the topological distance
- ALTO Servers provide ALTO Clients with info such as NO-centric view on network topology, and routing cost between network locations
- ALTO just describes attributes of caches and of their network locations
- Currently, ALTO provides static network information -> no feature to protect confidentiality of the NO topology information
 - ✓ One solution is to re-direct the ALTO information to a `Relay', to which the end user connects without getting the topology information
 - ✓ Relays offload mobile devices by taking over processing-intensive tasks as well as preventing easy access on the operator network topology

ALTO, overview



Combination of 1) & 2)

- The cost to access an endpoint is fundamental:
 - ✓ ALTO provides a generic cost value computed by the NO, it reflects its preferences
- However content location selection algorithms need to combine application specific metrics like bandwidth, memory capacity or latency for video related applications
- Design of a x-layer framework combining metrics from:
 - ✓ PHY, getting info via 802.21 about LTE and WiFi
 - ✓ IP, getting info about network costs via ALTO
 - ✓ APP, getting application-based info like BW, latency, jitter, etc...
- Optimization problem to be solved to get the path providing best QoE

Conclusions

- Starting from current trends in standardization, two key objectives being dealt within the MEDIEVAL research project: quasi-real time evaluation of the perceived QoE by end users and application requirements in terms of network resource usage

Immediate next steps

- QoE computation algorithms combined with application layer optimizations give a promising solution -> need to exploit the ALTO protocol and its extensions for the mobile core and to evaluate key metrics (QoE-based video metrics and network metrics) in simulation and live text experiments
- Investigation of cost functions and of “valuable” metrics from: IP (ALTO), PHY (802.21, WiFi and LTE) and application, to be used in a x-layer framework

QoE optimization with network layer awareness on hybrid wireless network

mailto: munaretto@dei.unipd.it

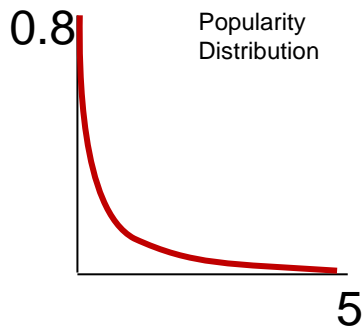
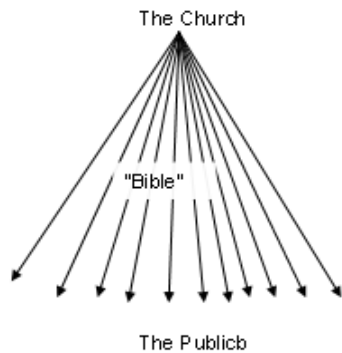
BACK UP

Key Contributions

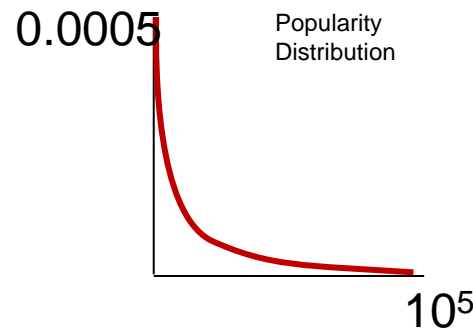
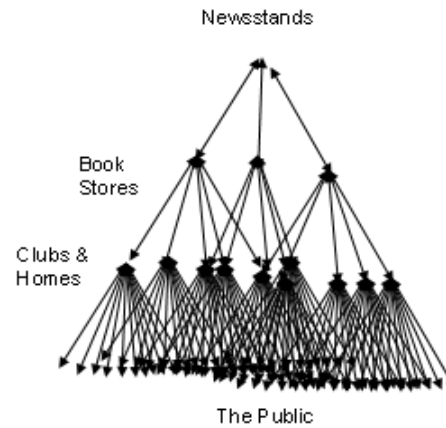
- 1) **Mobility:** efficient IP transport optimized for mobility and integration of CDN functionality in the mobile network
- 2) **Wireless:** cross-layer design to adapt the wireless access parameters to the transport network and video traffic requirements,
- 3) **Application:** feedback to the application layer (to support server data rate adaptation, transcoding, etc.).

Although the number of documents increases exponentially, the popularity distribution remains Weibull-/Zipf-distributed

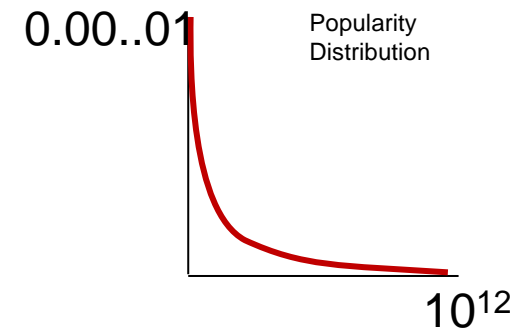
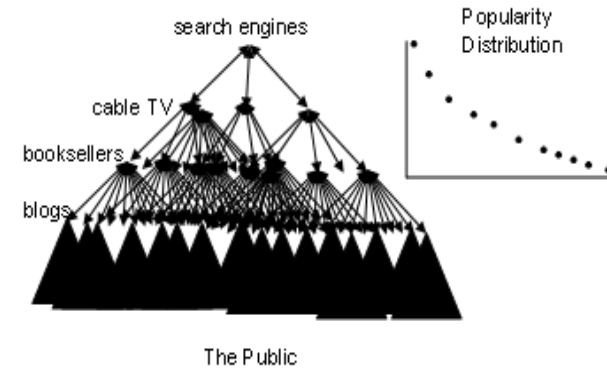
Year: 1450



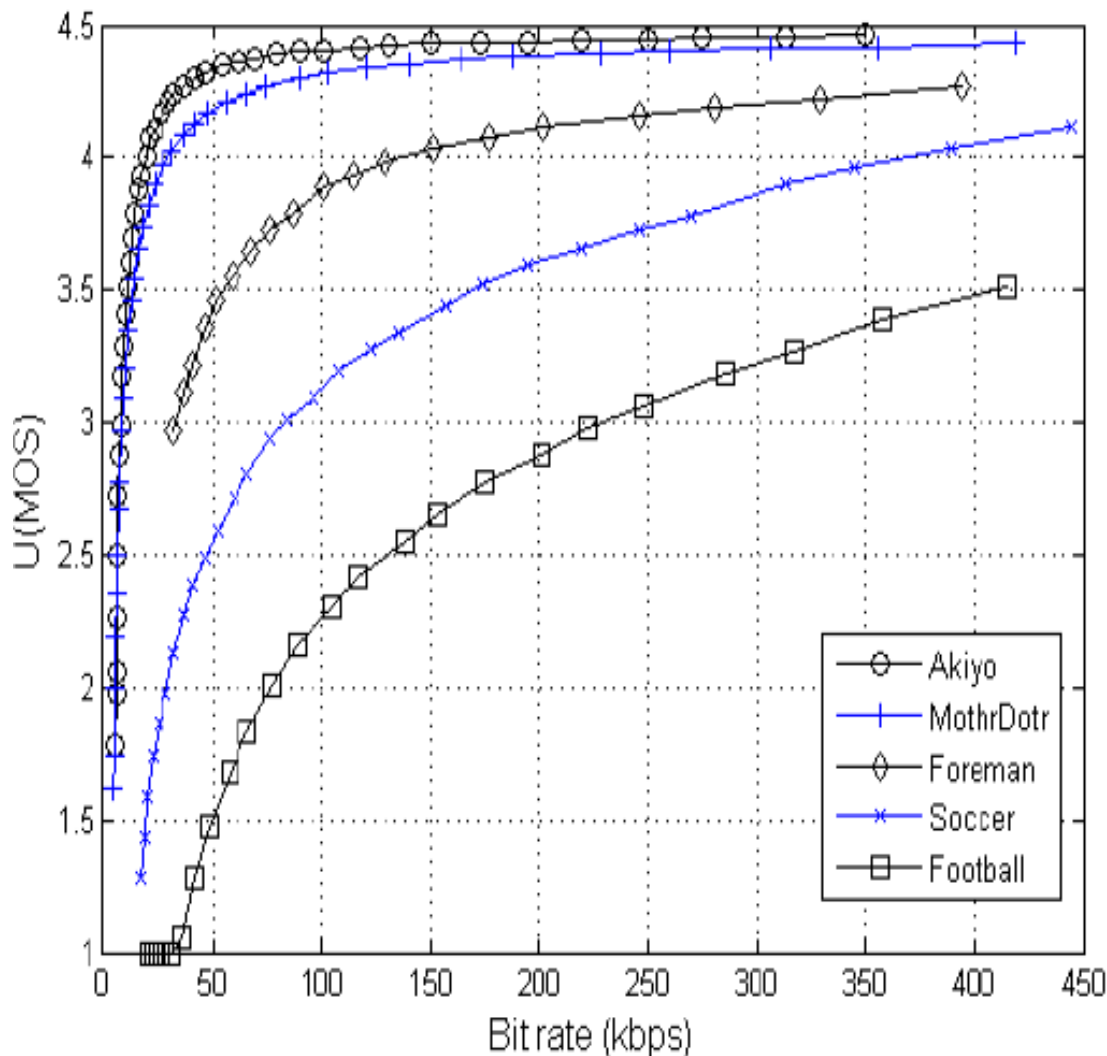
1950



2050 ?



QoE-based video sensitivity



Obs:

- video sensitivity as QoE vs. data rate
- QoE varies in a non-linear manner
- video content based sensitivity
- VSSIM linearly mapped to MOS
- maximizing throughput does not mean max quality!

Setting:

- QCIF resolution (176x144)
- 30 fps
- 400-480 kbps encoding rate