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Quality of Service in Mobile Networks

IRoNet seminar
11th December 2002, Espoo, Finland

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Introduction

- Internet growth is continuing and IP services are needed also in mobile environment.
- Currently GPRS is only widely distributed mobile system for IP services.
- Mobile environment has multiple of limitations:
  - Capacity is limited.
  - Throughputs are lower than in wired environment.
  - Delays are higher than in wired environment.
  - No differentiation between real-time and non-real-time service => All packet switched is best-effort.
- Thus, mobile environment sets new challenges for real-time IP services.

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Current status in mobile networks

- **Mobile networks are now GSM/GPRS:**
  - **Circuit switched speech and data.**
  - **Packet switched GPRS data.**
- **QoS matters only to for packet switched data.**
- **QoS has been specified for GPRS, but is not used now.**
- **Many performance issues, like throughputs, delays and error-ratios relates to QoS.**
- **UMTS and GPRS has the same packet core network => Same QoS mechanism. However, different radio technologies means differences in end-user quality, I.e. higher throughputs in UMTS.**
- **QoS start now being feasible and emerging in mobile networks.**

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Why we need QoS in mobile networks?

- **GPRS is best-effort, which is suitable for e.g. WAP, web-browsing or intranet-access. There are breaks, interruptions, delay spikes and throughput changes, but e.g. TCP-protocol can handle somehow these.**
- **Also backbone, core and radio network technology is moving towards All IP, and IP is by nature best-effort.**
- **There are coming service needs:**
  - **Streaming applications are coming into terminals. These will need throughput and delay guarantees.**
  - **IP multimedia is partly real-time, which needs low delay.**
  - **There will be multiple of simultaneous services, with different QoS requirements.**
  - **All of these should be supported by cost-efficient manner by using network resources efficiently.**

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Operator needs for QoS

- **Return of infra investments**
  - **Costly network resources should be used efficiently.**
  - **No over-provisioning.**
- **Service and user differentiation**
  - **E.g. business vs. consumer.**
  - **Real-time vs. best-effort.**
- **To be more than bitpipe provider.**
- **Ability to offer SLA's for VNO's.**
- **Service consolidation,**
  - **Most of the services are becoming IP-based, but QoS needs will be different.**
- **Service needs**
  - **New services like mobile streaming will need QoS support.**

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QoS technologies in mobile networks

There are two types of QoS technologies:

- **Internet or IETF technologies:**
  - **DiffServ and MPLS are planned for mobile core network transmission and towards Internet.**
  - **IntServ or RSVP (not relevant?)**
- **Wireless techniques:**
  - **3GPP has specified QoS framework, which can be used inside GPRS and UMTS.**
  - **ETSI has specified QoS for GPRS R97, but this is integrated into 3GPP QoS.**
  - **IEEE 802.11e, improvement for WLAN MAC to provide QoS. Not used yet.**
- **In wireless network the bottleneck is likely close to radio network:**
  - **QoS must first handle problems of this environment.**
  - **Also, QoS techniques must interact with technologies used in Internet.**

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Role of DiffServ in GPRS/UMTS

- **Technology for IP-networks => For interfaces using IP-transmission:**
  - **Behind the edge of the mobile network (GGSN).**
  - **Inside core network, I.e. between SGSN and GGSN.**
  - **In radio transmission if/when it evolves All-IP.**
- **Interoperability between other technologies needed, I.e. mapping between 3gpp model:**
  - **In GGSN towards IP backbone, mapping between 3GPP classes and DSCP's, which can be further used in IP/MPLS networks.**
  - **If DiffServ is used in GPRS core network, same mapping is needed in SGSN and GGSN.**
- **Target is to optimise use of IP-transmission inside mobile core network and behind it.**
- **DiffServ is not seen be end-user or services.**

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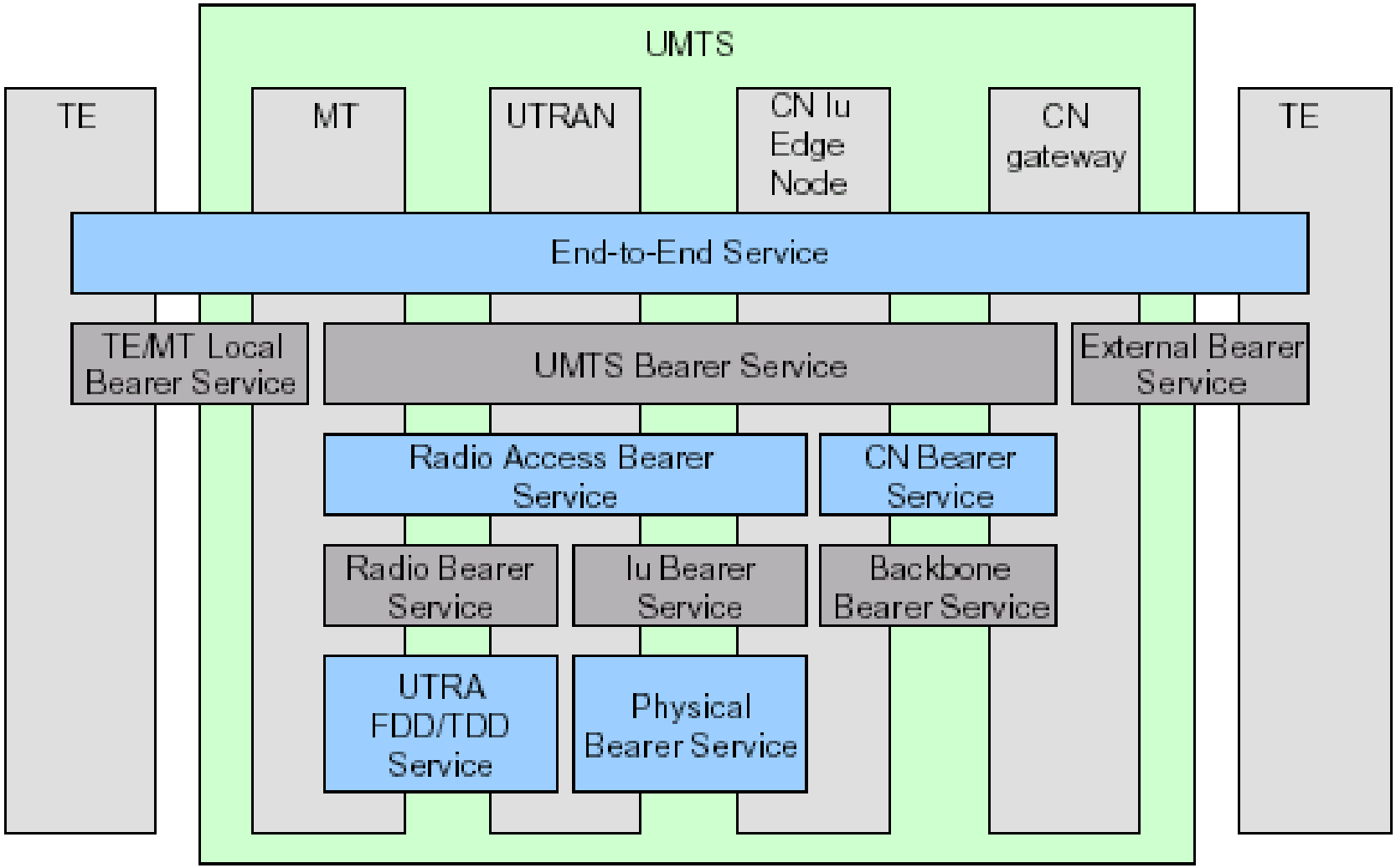
Role of 3GPP QoS

- **Specified for mobile networks (UMTS, GPRS).**
- **Consists bearers, in many levels, and over certain logical parts of network. Target to give suitable bandwidth, priority, delay, error-ratio, etc. for certain services.**
- **Effects to what quality end-user or service gets in mobile specific interfaces.**
- **Has mapping into DSCP's, in SGSN and GGSN.**
- **Implementation is not specified => vendor specific.**

3GPP QoS model, Architecture



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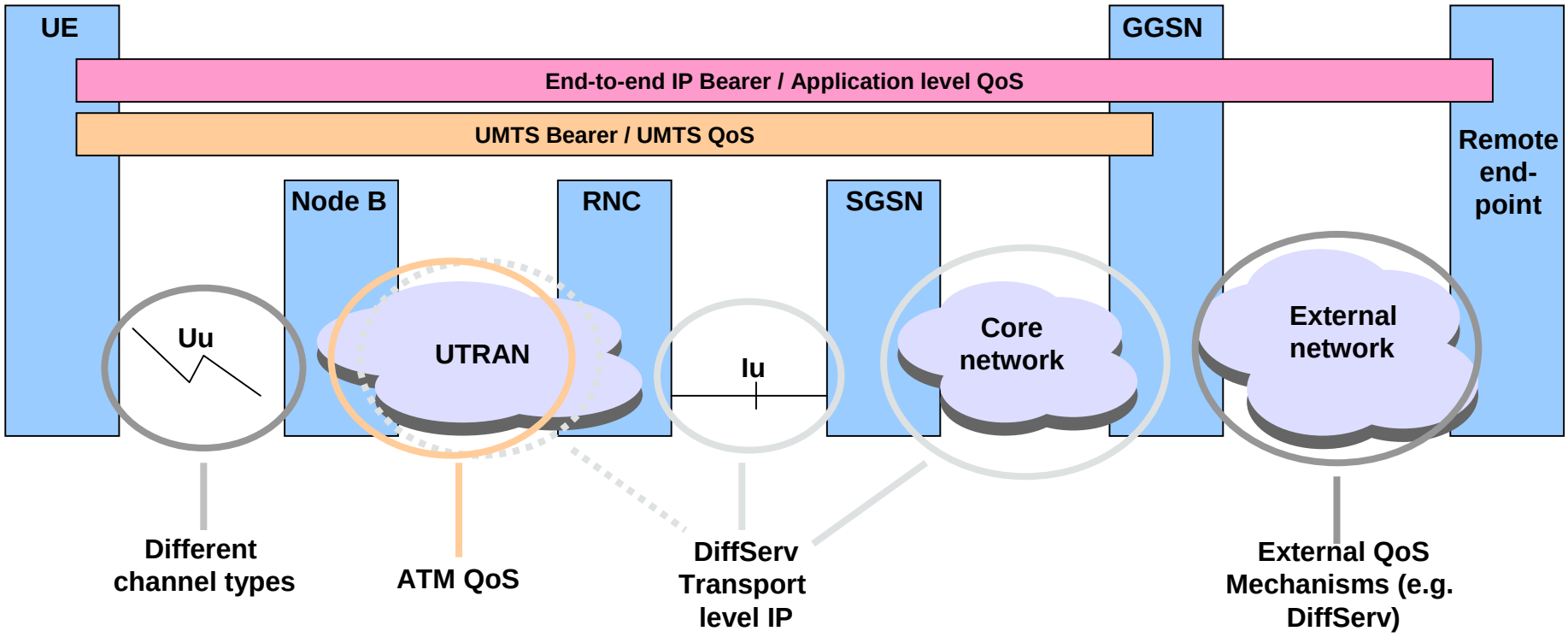
3GPP QoS model, Classes

- **3GPP QoS classes define a framework what kind of access network should provide for services.**
- **However, the model does not specify exactly how these are implemented.**
- **It is up-to operator how these classes are further provided for subscribers.**

Traffic class	Conversational class	Streaming class	Interactive class	Background class
Fundamental characteristics	Preserve time relation (variation) between information entities of the stream Conversational pattern (stringent and low delay)	Preserve time relation (variation) between information entities of the stream	Request response pattern Preserve content	Destination is not expecting the data within a certain time Preserve payload content
Example of application	Voice	Streaming video	Web browsing	E-mail

Simplification of QoS model, UMTS example



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QoS and services

- Terminal can request certain QoS profile, but SGSN can downgrade this, either because subscription profile in HLR is lower or because network resources are limited.
- The connection between applications and QoS is not clear:
  - Terminal application should request suitable QoS profile.
  - If application runs e.g. over http there are no connection into QoS profile.
  - Application server can not affect into this model.
- Streaming services and IP multimedia system will change this model:
  - First session started with primary PDP context, which is mainly used for signalling.
  - Then multimedia session is started by requesting secondary PDP context(s).
  - QoS negotiation is done between terminal and servers => Application can effect into QoS profile.
- However, the problem of this model is complexity, I.e. multiple of QoS mappings.

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Benefits vs. challenges

- **QoS techniques exists both in IP and cellular networks.**
- **These will help in network optimisation and to support new services.**
- **Real-time applications can be supported in packet switched wireless networks.**
- **QoS is a way to build manageable quality real-time multimedia services.**

- **QoS techniques will not make networks simpler.**
- **QoS is a bit engineers dream, do end-users really want it.**
- **Service level QoS will take time to be implemented.**

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Conclusion

- QoS techniques are coming into mobile networks.
- The need comes from real-time applications and the fact that e.g. GPRS is best-effort.
- There are two types of techniques:
  - 3GPP QoS, to control mobile specific QoS.
  - DiffServ, to optimise IP transmission.
- QoS techniques will have connection into applications, but this takes time.
- QoS gives benefits for operators in sense of network optimisation and enabling new services. For end-users the benefit comes from support of real-time services over IP access.

Make things click.