Mobile Broadband QoS

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QoS Today

- Subscription profile
  - Every end user has associated with them a subscription record which contains information about the specific QoS profile
  - These values are applied within the network by taking the QoS characteristics that the end user's device requests at the start of the session, and negotiating (downwards if necessary) within the network based on availability of network and/or radio resource availability
  - Once negotiation is complete, a session is either established with the negotiated QoS characteristics applied, or is rejected if there is insufficient resource in the network to maintain the specific service or application.

QoS Classes in UMTS

- There are four different QoS classes:
  - conversational class;
  - streaming class;
  - interactive class; and
  - background class.

QoS Bearer Attributes

Traffic class		Conversational class			Streaming class		Interactive class		Background class	
Maximum bitrate		X			X		X		X	
Delivery order		X			X		X		X	
Maximum SDU size		X			X		X		X	
SDU format information		X			X					
SDU error ratio		X			X		X		X	
Residual bit error ratio		X			X		X		X	
Delivery of erroneous SDUs		X			X		X		X	
Transfer delay		X			X					
Guaranteed bit rate		X			X					
Traffic handling priority		X								
Allocation/Retention Priority		X			X		X		X	
Signalling indication		X								

QoS Attribute Values

Traffic class		Conversational class			Streaming class		Interactive class		Background class		
Maximum bitrate (kbps)		256 000			256 000		256 000		256 000		
Delivery order Yes/No Yes/No Yes/No		Yes/No			Yes/No		Yes/No		Yes/No		
Maximum SDU size (octets)		1500			1500 or 1502		1500 or 1502		1500 or 1502		
Delivery of erroneous Sdus		Yes/No			Yes/No		Yes/No		Yes/No		
Residual BER		5*10-2, 10-2, 5*10-3,			5*10-2, 10-2, 5*10-3,		4*10-3, 10-5, 6*10-8		4*10-3, 10-5, 6*10-8		
		10-3, 10-4, 10-5, 10-6			10-3, 10-4, 10-5, 10-6						
SDU error ratio		10-2, 7*10-3, 10-3, 10-4,10-5			10-1, 10-2, 7*10-3, 10-3,		10-4, 10-5		10-3, 10-4, 10-6 10-3, 10-4, 10-6		
Transfer delay (ms)		<100			<300						
Guaranteed bit rate (kbps)		<256 000			<256 000						
Transfer delay (radio) ms		<80			<300						

QoS Monitoring when roaming

		Monitoring by HPMN (H)			Monitoring by VPMN (V)		
	Methods:	End-to-end Active Testing & Monitoring	SS7 Monitoring	CAMEL Monitoring	End-to-end Active Testing & Monitoring	SS7 Monitoring	CAMEL Monitoring
Qos Parameter	GRQ Test Code	A	B	C	A	B	C
Packet Switched LU Success Rate (PS LU – SR)	31	Y	Y (PS2)	N/A	Y	Y (PS2)	N/A
Packet Switched Location Update Delay (PS LU – D)	32	Y (PS1)	Y	N/A	Y (PS1)	Y	N/A
Service accessibility for PSD (PDP-context activation success rate)	33	Y	Y (PS3)	Y (PS8)	Y	Y	Y (PS13)
Set-up Delay (ST PSD)	34	Y	Y (PS4)	Y	Y	Y	Y (PS13)
PDP Context Cut-Off Ratio	35	Y	N (PS5)	Y	Y	N (PS5)	Y (PS13)
Average PDP Context Session Time (per APN)	36	N	Y	Y	N	Y	Y (PS13)
Throughput (Kbits/sec)	37	Y (PS6, PS14)	Y (PS15)	Y (PS9, PS15)	Y (PS14)	Y (PS15)	Y (PS9, PS15)
Goodput (Kbits/sec)	38	Y (PS6, PS14)	Y (PS15)	N (PS10)	Y (PS14)	Y (PS15)	N (PS10)
Roundtrip time	39	Y (PS6, PS14)	Y (PS7, PS15)	N (PS11)	Y (PS14)	Y (PS7, PS15)	N
Packet loss	40	Y (PS6, PS14)	Y (PS7, PS15))	N (PS12)	Y (PS14)	Y (PS7, PS15)	N

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QoS Measuring techniques

Packet Switched LU Success Rate (PS LU – SR)	Measure MAP GPRS Update Location procedure. Can be measure on SCCP and TCAP level.	
Packet Switched LU Success Rate (PS LU – SR)	Measure MAP GPRS Update Location procedure. Can be measure on SCCP and TCAP level.	
Packet Switched Location Update Delay (PS LU – D)	Measure the time between the MAP UL request until the MAP UL ACK	
Packet Switched Location Update Delay (PS LU – D)	Measure the time between the MAP UL request until the MAP UL ACK	
Service accessibility for PSD (PDP-context activation success rate)	Measure ratio between successful MAP_PDP_Context Activation and attempts	
Service accessibility for PSD (PDP-context activation success rate)	Measure ratio between successful MAP_PDP_Context Activation and attempts	
Set-up Delay (ST PSD)	Measure timing between successful MAP_PDP_Context Activation Request and Response	
Set-up Delay (ST PSD)	Measure timing between successful MAP_PDP_Context Activation Request and Response	
PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	N/A	
PDP Context Cut-Off Ratio (session Stability measured at PDP context or PS level)	N/A	
Average PDP Context Session Time (per APN)	Measure time between the MAP_PDP Activation and the MAP_PDP_Delete message	
Average PDP Context Session Time (per APN)	Measure time between the MAP_PDP Activation and the MAP_PDP_Delete message	
Throughput (Kbits/sec)	Measure UDP Packet volume exchanged	
Throughput (Kbits/sec)	Measure UDP Packet volume exchanged	
Goodput (Kbits/sec)	Measure UDP Packet volume exchanged, corrected by filtering UDP containing TCP retransmission	only application based on TCP
Goodput (Kbits/sec)	Measure UDP Packet volume exchanged, corrected by filtering UDP containing TCP retransmission	only application based on TCP
Roundtrip time	Measure UDP roundtrip based on encapsulated TCP acknowledgement mechanisms	only application based on TCP
Roundtrip time	Measure UDP roundtrip based on encapsulated TCP acknowledgement mechanisms	only application based on TCP
Packet loss	Measure UDP Packet Loss based on TCP retransmission mechanisms	only application based on TCP
Packet loss	Measure UDP Packet Loss based on TCP retransmission mechanisms	only application based on TCP

Future Requirements

2002 – 3	2003 - 4	2005 - 6	2007 – 9	Next decade (NGMN)
64 – 144 kbps	64 – 384 kbps	0.384 – 4 Mbps	0.384 – 7 Mbps	20+ to > 100 Mbps

DL Throughput

Please note that these are peak data rate reference values in good radio conditions

- ***Next Generation Mobile beyond 3G - NGMN***
  - Seamless Mobility, low-latency, high throughput, QoS, Secure
  - Beyond HSPA and EV-DO Rev A
  - Multiple service Classes. Legacy support, service continuity

- ***What does this mean***
  - Core <10ms
  - RAN <10ms
  - e2e < 30ms.
  - Minimum Packet loss
  - Less than <300 ms handover NGMN to Legacy (2G or 3G)

- **How**
  - All Packet, Flat architecture, CS emulation
  - Access eNB and access gateway

NGMN - Services

- ***Functionality***
  - End user services utlilised across multiple access and network types
    - IM, PoC
  - Service enablers supporting a range of end user services as specified by OMA
    - Presence, Identity and device management
  - Resource control mechanisms and access network selection to ensure optimum resource assignment for each service.
    - Media resource control, policy control, security mechanisms, lawful intercept, content filtering

Optimising QoS in (LTE) Networks

- Proposed Techniques
  - Provide user and service differentiation for single and parallel services guaranteeing minimum bit rates and low latencies for both downlink and uplink directions.
  - Avoid misuse of radio and transmission resources, e.g., it is contention free with an optimised e2e packet scheduling.
  - Allow for definition of QoS policies, their enforcement, prioritisation, and re-marking at the optimum point in the architecture.
  - Support efficient QoS in an architecture, which inherently has a very high-level of fan-out/fan-in (e.g., where many terminals interact with one base station, or where many base stations interact with one terminal).
  - Manage the level of QoS allocated to an individual subscriber's session.
  - Should be able to communicate session QoS requirements to other access networks so that QoS can be supported, if such a capability exists.
  - Shall support contemporary features such as connectionless QoS, DiffServ marking, or content inspection.
  - Shall provide optimum e2e QoS for all recommended radio access with service continuity.
  - Shall support QoS management for multicast/broadcast services.

Requirements for LTE and E-UTRAN

- The objective of Evolved UTRA and UTRAN is to develop a framework for the evolution of the 3GPP radio-access technology towards a high-data-rate, low-latency and packet-optimized radio-access technology,
- Target for a Radio-access network latency (user-plane UE – RNC (or corresponding node above Node B) -UE) below 10 ms, and
- Aim for significantly reduced C-plane latency (e.g. including the possibility to exchange user-plane data starting from camped-state with a transition time of less than 100 ms (excluding downlink paging delay

Capability Requirements

- Control Plane
  - Transition time (excluding downlink paging delay and NAS signalling delay) of less than 100 ms from a camped-state, such as Release 6 Idle Mode, to an active state such as Release 6 CELL_DCH, in such a way that the user plane is established.
  - Transition time (excluding DRX interval) of less than 50 ms between a dormant state such as Release 6 CELL_PCH and an active state such as Release 6 CELL_DCH
- User Plane
  - U-plane delay is defined in terms of the one-way transit time between a packet being available at the IP layer in either the UE/RAN edge node and the availability of this packet at IP layer in the RAN edgenode/UE. The RAN edge node is the node providing the RAN interface towards the core network.
  - Specifications shall enable an E-UTRA U-plane latency of less than 5 ms in unload condition (ie single user with singledata stream) for small IP packet, e.g. 0 byte payload + IP headers E-UTRAN bandwidth mode may impact the experienced latency

QoS in Today's Mobile Networks

- RAN interfaces implemented in compliance with 3GPP TS 23.107 may currently use the Differentiated Services model to mark differentiated traffic depending on its application and end user subscription details. Similar mechanisms are required for Policy enforcement on other interfaces in the Mobile Network domain.

- It is assumed that a carrier grade IP transport network is in place (see IPX), and that the ability to support DiffServ , based on DSCP marks is implemented through the network

- Other network functions would be unaffected. Transport layer entities, such as routers would need to transport DSCP marking and react as specified in DiffServ recommendations, but SGSN and RNC do not operate at the Transport layer and so would not need to change their functionality to allow DSCP marks to pass.

QoS Across Interconnected Networks

- GRX/IPX
  - The support of DiffServ and DSCP across inter-operator interconnects requires extension into the GRX and IPX to allow end-to-end QoS capabilities to be applied.
  - The potential for this additional benefit to be made available across interconnect reinforces the need for a shared implementation strategy across the operator community, and for this to be extended into Carrier operators that offer todays GRX and/or IPX service in the future.

APPENDIX A

- Interconnected Mobile Networks using the GRX/IPX

Appendix A

- The GRX
- Enhanced GRX and Next Generation Roaming
- The Opportunity for IP Interworking
- The Key Principles of the GSMA's proposition
  - Openness
  - Quality
  - Cascading Payments
  - Efficiency
- The IP eXchange – IPX

The GRX

- **GPRS Roaming Exchange**
  - Data & MMS services for 2.5G and 3G data services
  - Mobile network operators only
  - No QoS
  - Hugely successful
  - Opt-in service
  - Private peering points US, Asia and US

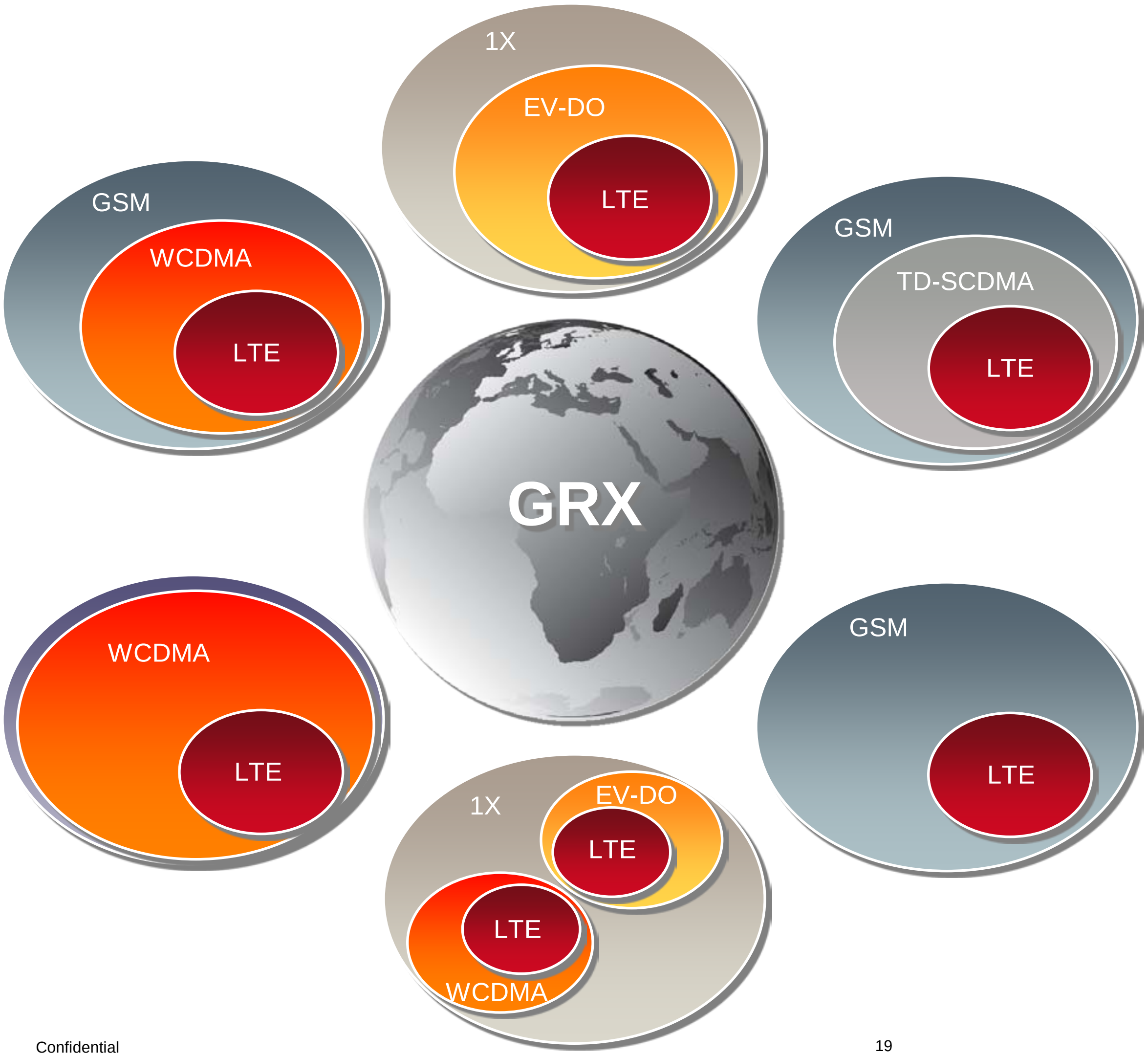
- **GRX is the platform for migration to IPX**

GRX Providers

- GRX member list

Aicent
Akton
Belgacom
Cable and Wireless
Citic Telecom
Comfone AG
Emirates Telecommunications
France Telecom
KPN Global Carrier Services
Multiregional Transit Telecom
Neustar
OTE International
Portugal Telecom
REACH
Singapore Telecom
Syniverse
T-Systems International TDC
Solutions
Tele2
Telecom Austria
Telecom Italia
Telecom New Zealand UK
Telefonica IWS
Telenor Global Services
TeliaSonera International

Roaming Futures - GRX Enhanced

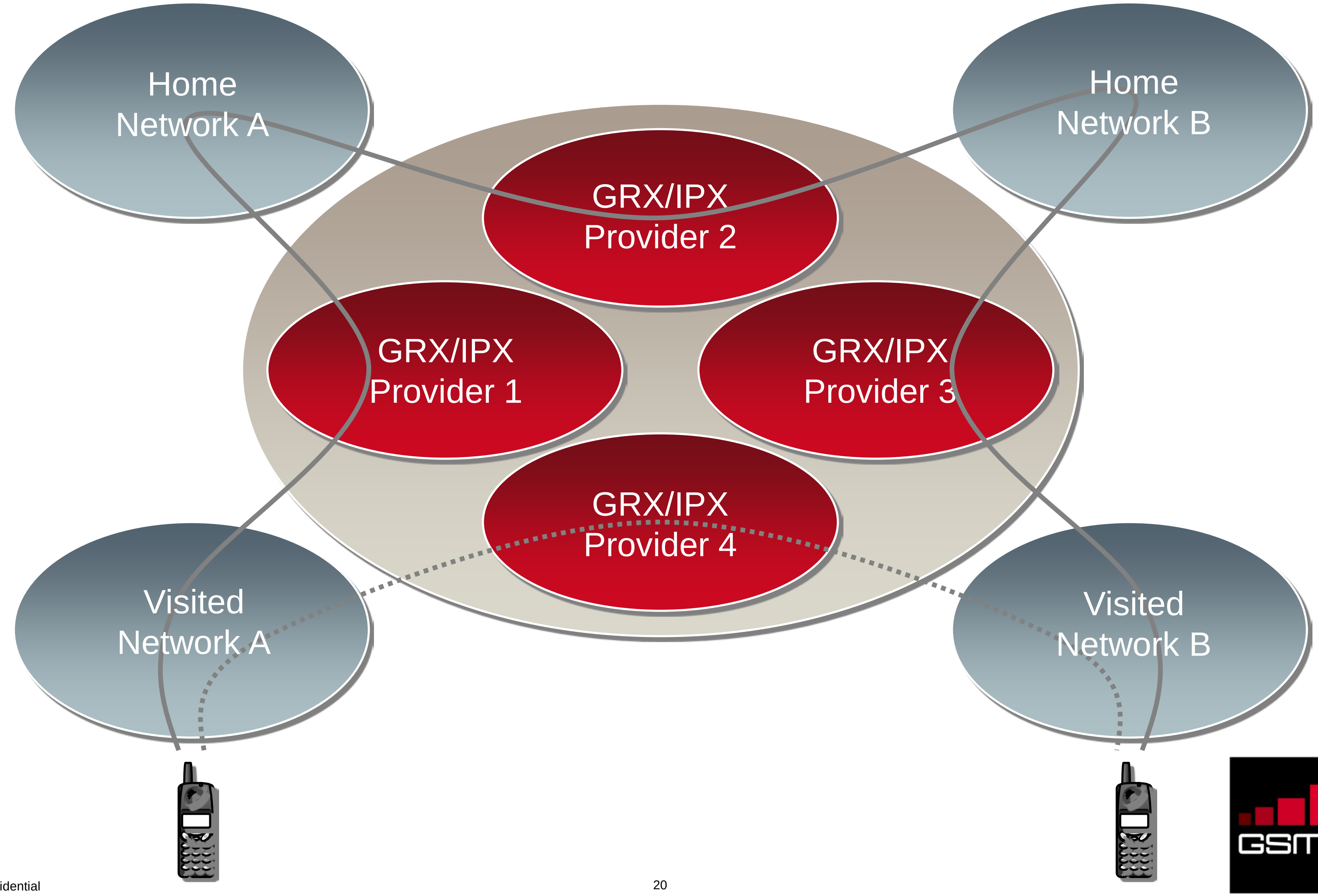


- GRX as the basis for LTE/EPC Roaming

GRX will need to

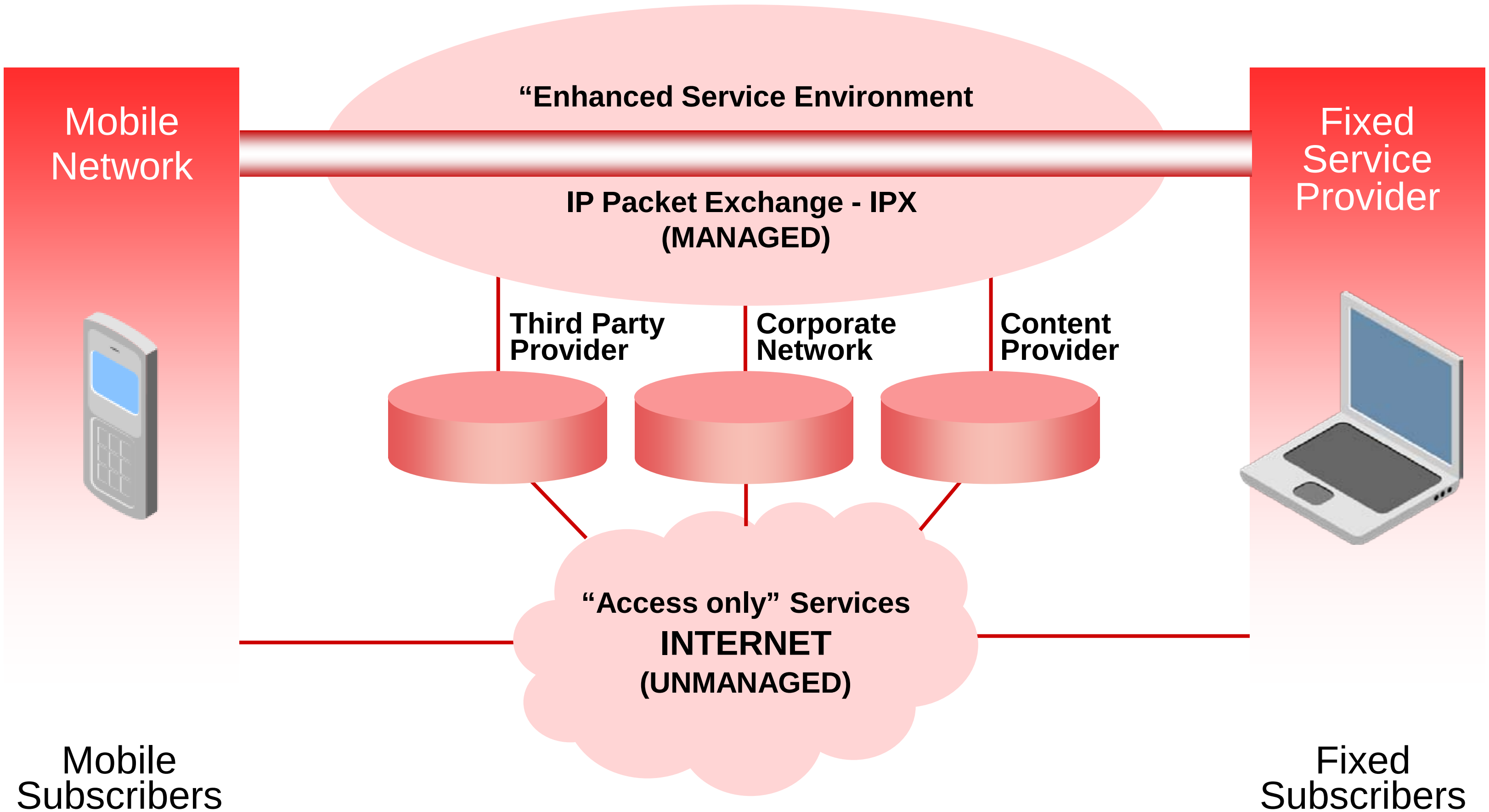
- Support new protocols and interfaces
  - GTPv2, MIP, Diameter
- Possibly implement new charging principles (and hence new/revised CDR formats)
  - May be a requirement for service-aware roaming
- Longer term, support signalling and charging for Visited network services

Future Roaming Scenario



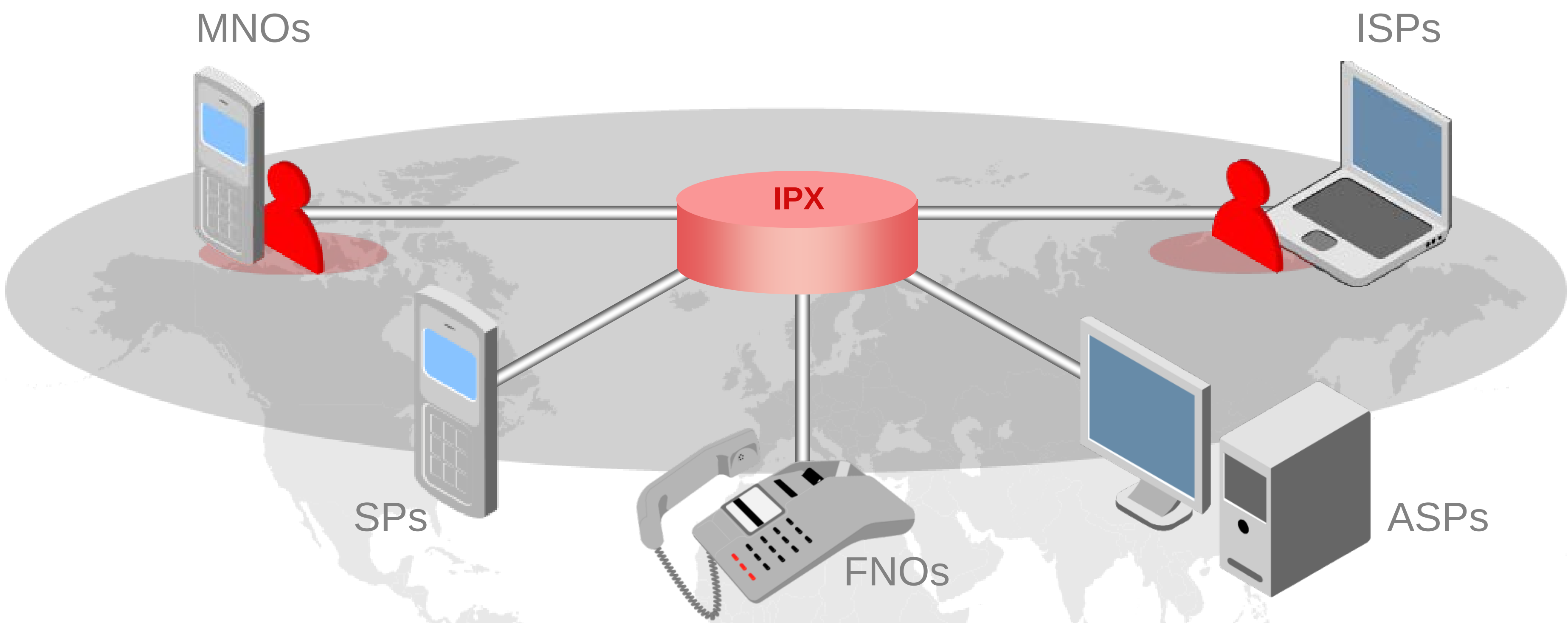
Introducing the IP eXchange – IPX

Managed Service Environment



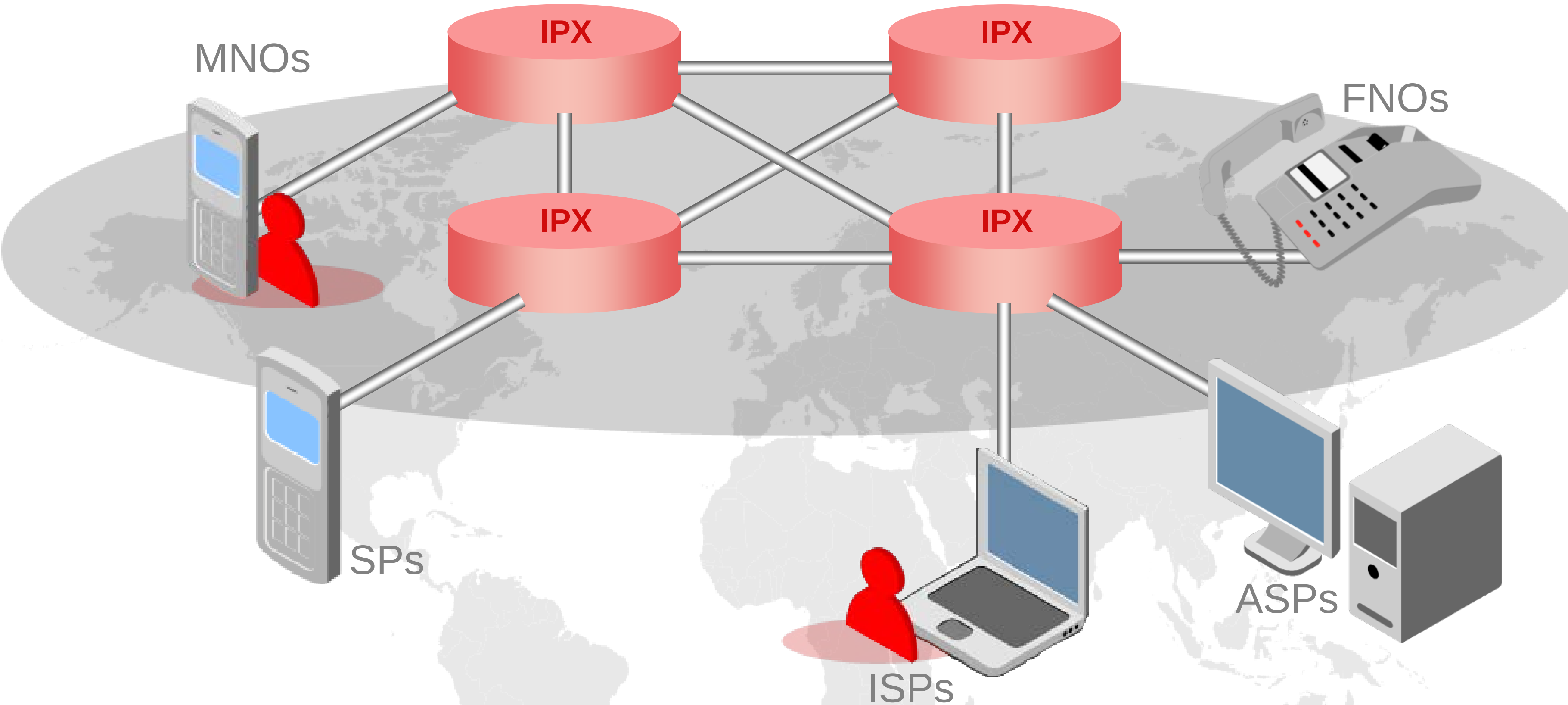
- IPX delivers a secure and reliable QoS solution
- Coexistence of both models leaves choice to the customer

IP eXchange - IPX



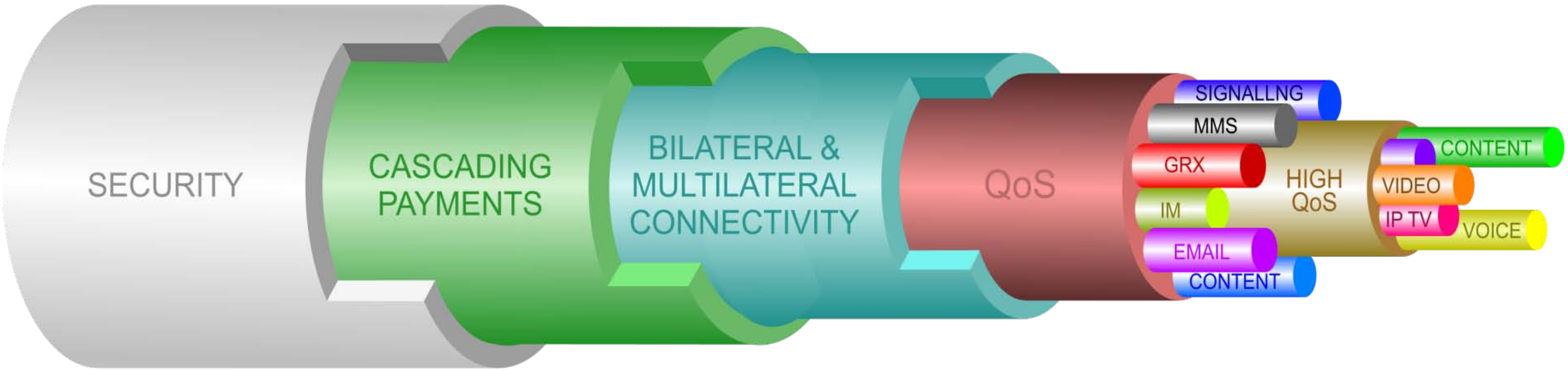
- **Applicability**
  - Mobile Network Operators (MNOs)
  - Fixed Network Operators (FNOs)
  - Internet Service Providers (ISPs)
  - Application Service Providers (ASPs)

IPX – one contract, many partners



- **Bi-lateral and**
- **Multi-lateral partnership modes**

IPX – Key Components



- IPX traffic has managed QoS at various levels of performance
- Payments associated with the business model are identified and settled between operators
- Operators are free to select bi-lateral or the efficient multi-lateral modes of interconnection for different types of traffic
- All IP traffic is protected
- Services not requiring premium quality can use less demanding QoS bearers

IP Services on the IPX

- IPX Services are standardised
  - common charging principle
  - technically inter-operable end to end
- Service Providers can decide to use the IPX by choosing
  - the Service they want to interwork over the IPX
  - the Service Providers they want to interwork with
  - which service interworking they need with the IPX carriers
- Agreements specified in a Contract Service Schedule containing
  - SLA
  - connectivity model
  - operator interconnection list

Progress

- IPX design validated through end-to-end trials
  - 22 Service Providers (Fixed, GSM and CDMA)
  - 14 IPX providers
  - 8 SIP-I platforms
  - 20 countries in 5 continents
- Template agreements and annexes available
  - Voice, MMS, SMS, Video Share
- SIP-I Interoperability Testing
- Performance monitoring architecture defined

Questions?

References; 3GPP TS 23.107; TR 25.913 ; 25.304 ; PRD IR.81 ; NGMN Alliance V3.0 Whitepaper, IPX Collateral @ http://www.gsmworld.com/ipi/index.shtml

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