ITU-T Study Group 12

End to End QoS Control

in VoIP Systems

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Telchemy

Characterizing
End-to End QoS

Approach to Characterizing Multimedia QoS

- QoS is defined subjectively as perceived by the user,

- It is end to end (e.g. mouth to ear for speech),

- A number of QoS Service Classes are defined,

- Classes include guaranteed quality (statistically) and unguaranteed (best effort).

The TIPHON Speech QoS Classes

Class	Wideband	Narrowband			Unguaranteed (Best Effort)
		High	Medium	Acceptable	
Listener Speech Quality **(One-way Non-conversational)**	**Better than G.711**	**Equivalent or better than G.726 at 32 kbit/s**	**Equivalent or better than GSM-FR**	**Undefined**	**Undefined**
End-to-end Delay (G.114)	**< 100ms**	**< 100ms**	**< 150ms**	**< 400ms**	**< 400ms***
Overall Transmission Quality Rating (R)	**N.A.**	**> 80**	**> 70**	**> 50**	**> 50***

* Target

Parameters Determining QoS in IP Networks

Inter-relationship of QoS Factors

Network Packet Loss → Overall Packet Loss → Codec Performance

Network Jitter → Jitter Buffers

Jitter Buffers → Overall Packet Loss

Codec Performance → Perceived Quality

Codec Performance → Overall Delay

Network Delay → Overall Delay

Jitter Buffers → Overall Delay

Overall Delay → Perceived Quality

Network Factors

Application Factors

QoS Service Level

Workshop on QoS and user-perceived transmission quality in evolving networks

QoS Parameters

QoS Service Class	ITU-T SG12/16
	SERVICE

Codec Performance, VAD, Frames per Packet, Jitter Buffer Size, Codec Delay, FEC (Redundancy)	ITU-T SG16/11
	APPLICATION

Max Packet Loss, Max Mean Delay, Max Delay Variation	ITU-T SG13/IETF
	TRANSPORT

An End-to-end QoS Architecture

General Architecture

Management Plane

SCN Plane

IP Application Plane
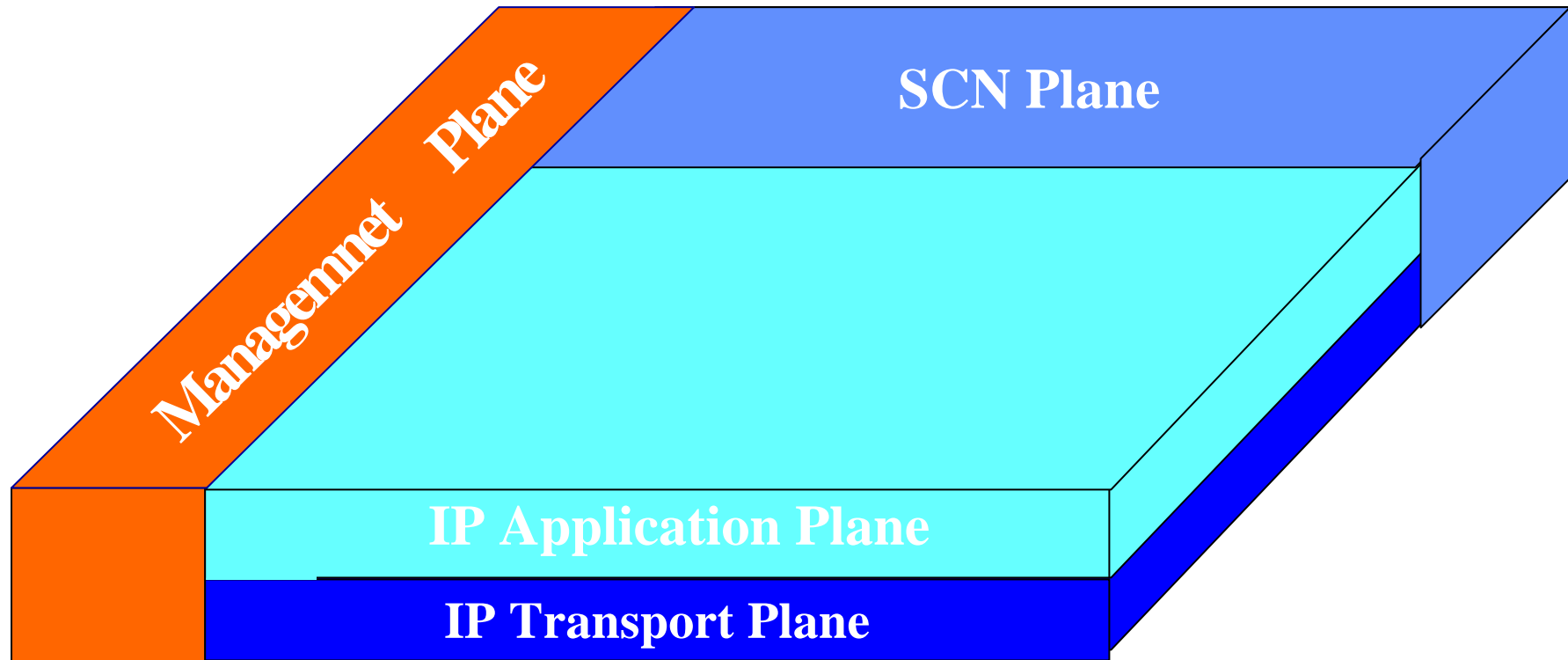
IP Transport Plane

Components of a QoS Architecture

Application Plane

- Within this plane, QoS parameters specific to the application (e.g. Codec type, packetization, frames/sec etc) are requested, authorised, signalled, controlled and accounted.

IP Transport Plane

- Within this plane, general non-application specific parameters effecting QoS, (e.g. end-to-end delay, delay jitter, packet loss and bandwidth) must be controlled and accounted to achieve the QoS requirements requested by the application.
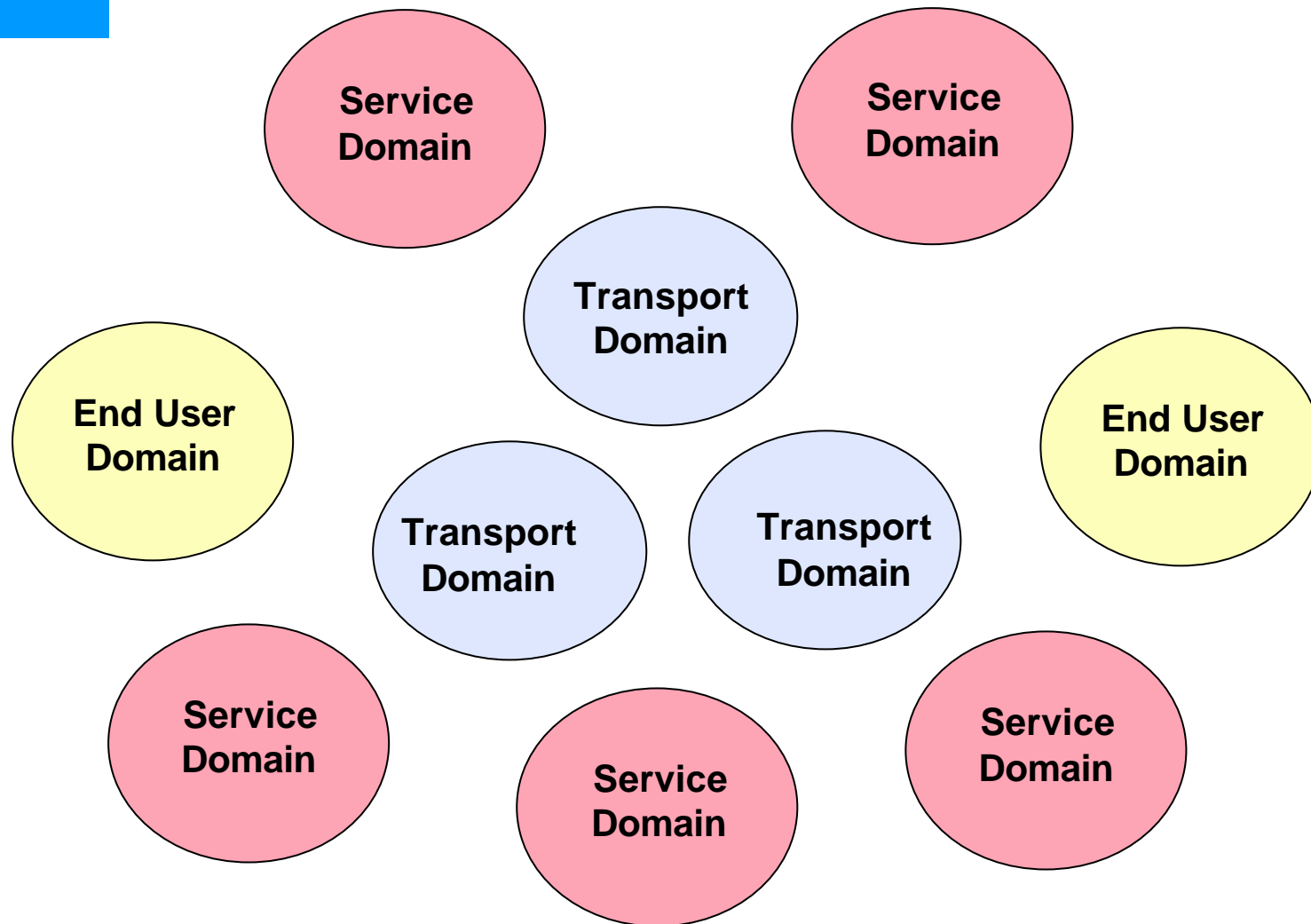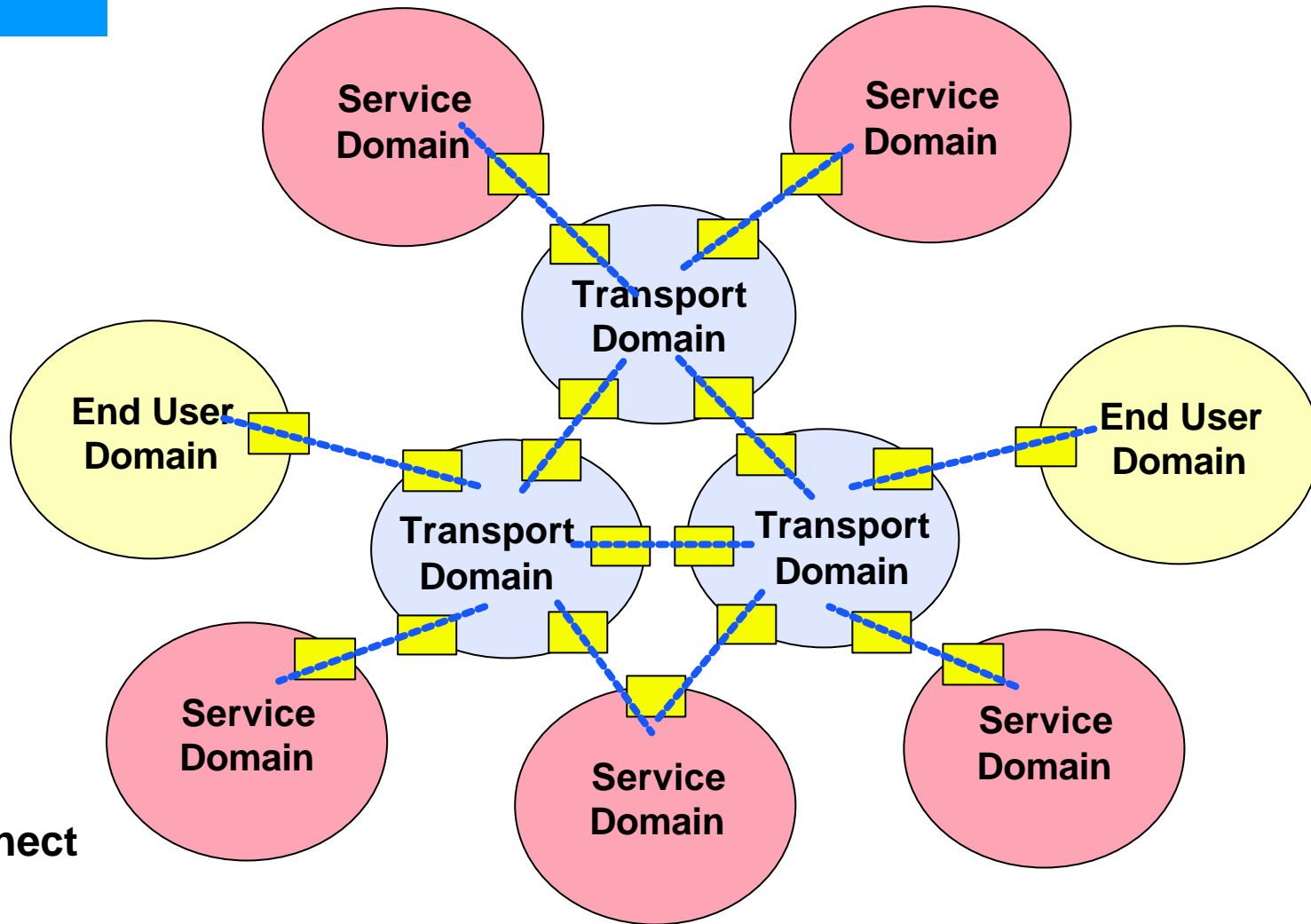
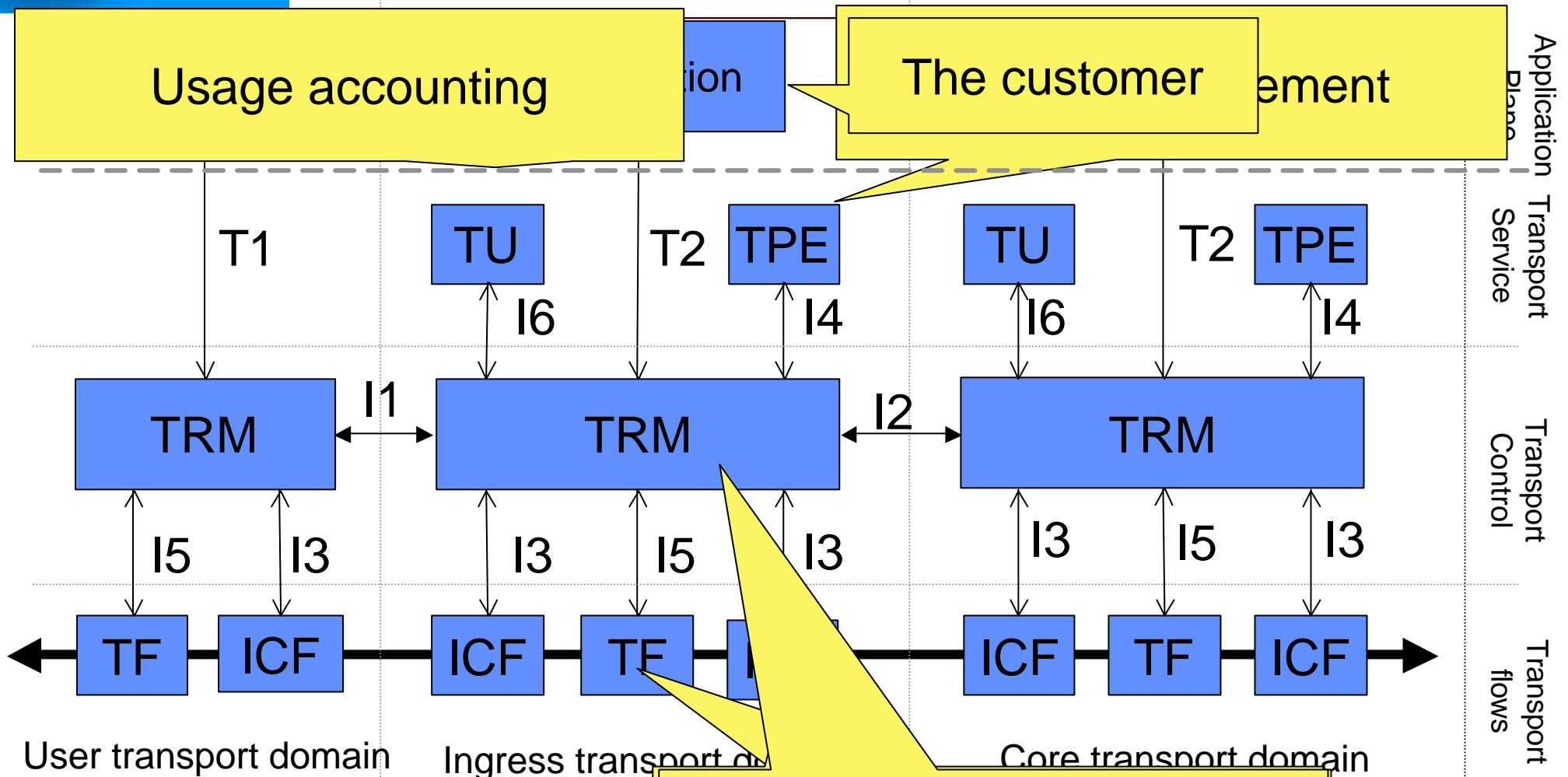# Administrative Domains
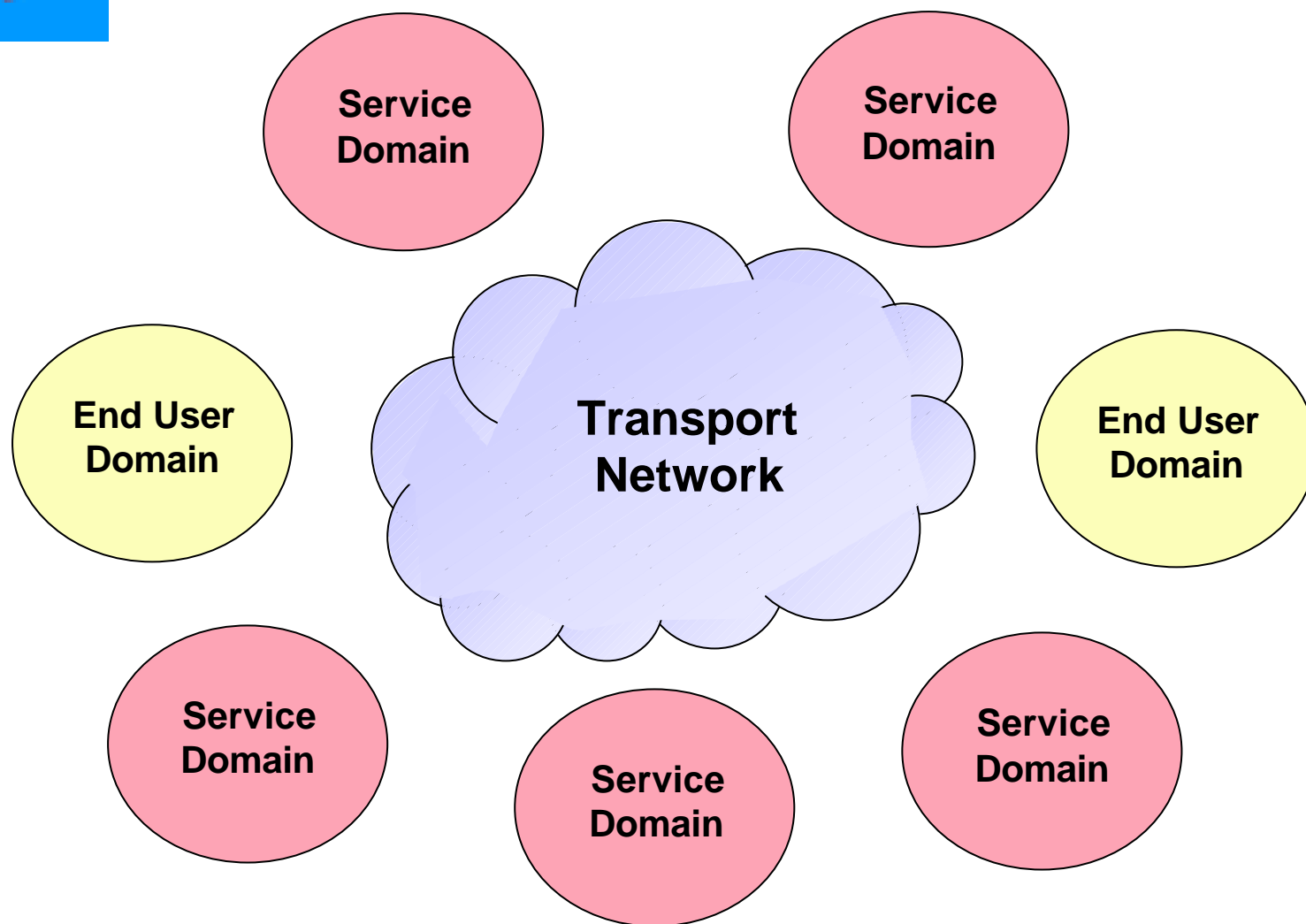
Domains - Managed Networks Model

Domain InterConnection

Transport plane functionality

Usage accounting

The customer

Control of the system
(access control, metering)

QoS Signalling to Transport Domain

ICF — InterConnect Function

TRM — Transport Resource Manager
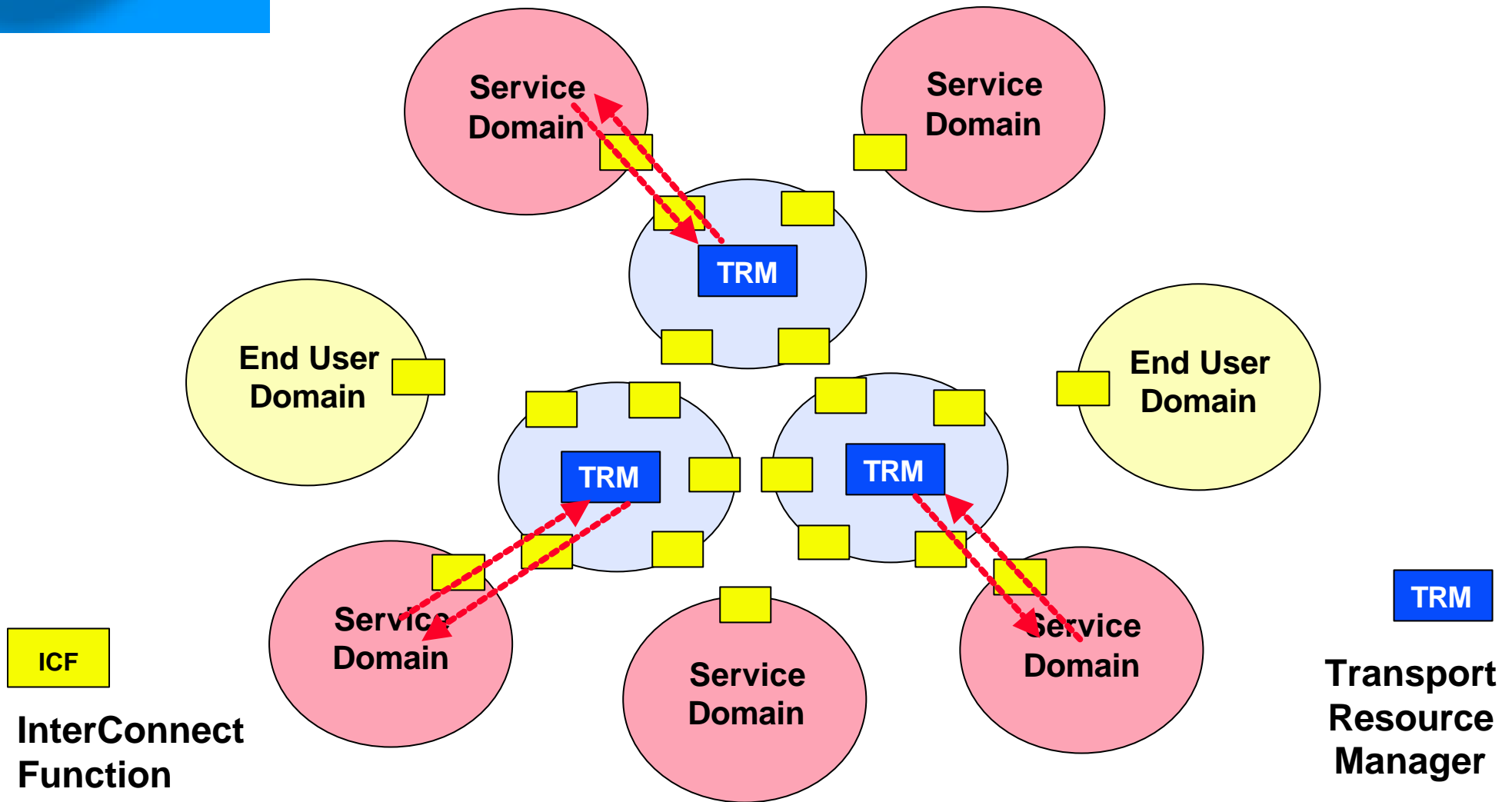
QoS Signalling within Transport Domain

Service Domain

Service Domain

End User Domain

TRM

TRM

TRM

End User Domain

Service Domain

Service Domain

Service Domain

ICF

InterConnect Function

TRM

Transport Resource Manager
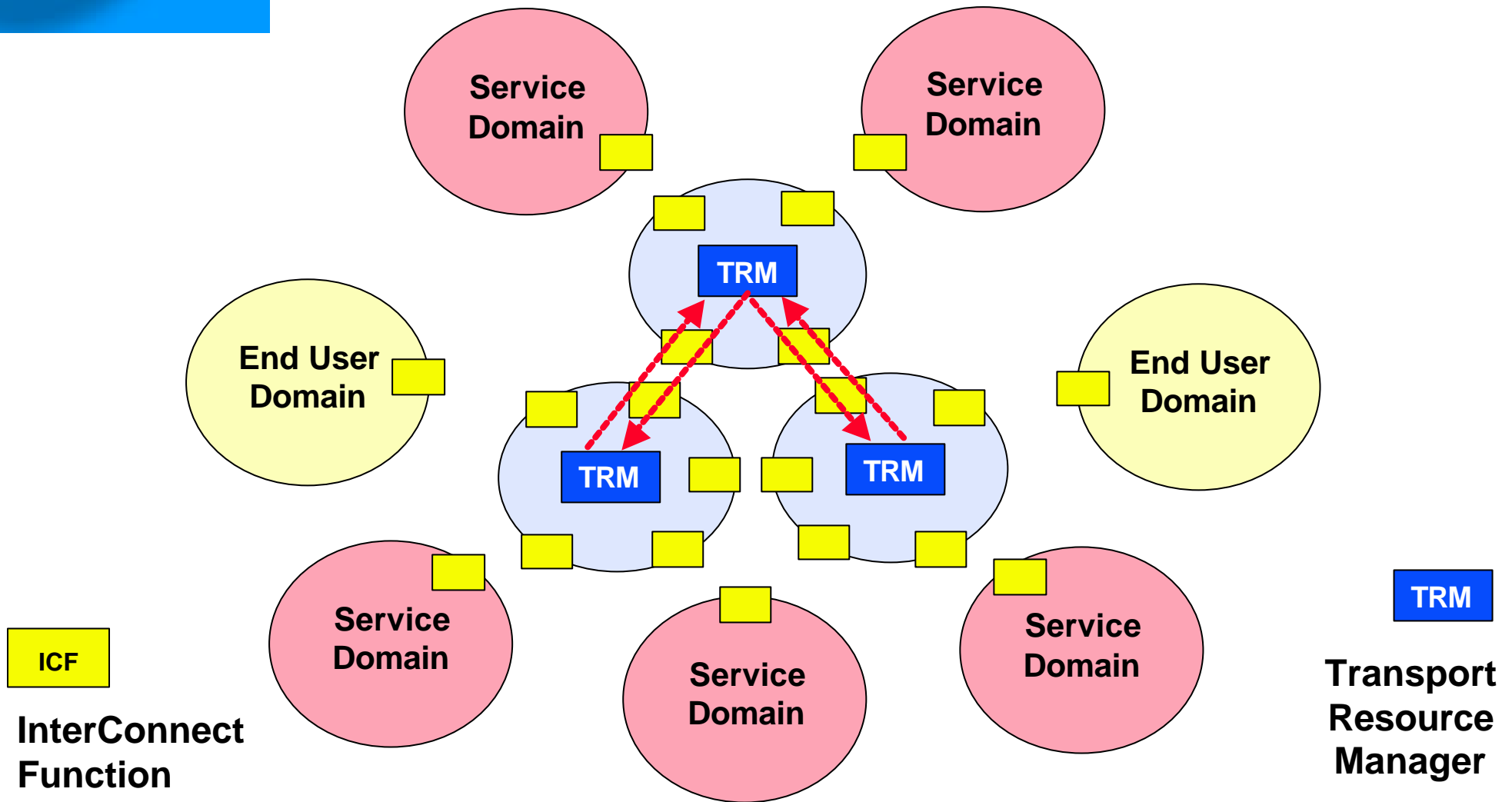
Delivering QoS
End-to-end

The Concept of QoS Budgets

End-to-End Budgets

End-Point Budgets

End-Point Budgets

Transport Domain budgets

End Point1

End Point 2

Transport Domain 1

Transport Domain 2

Transport Domain 3

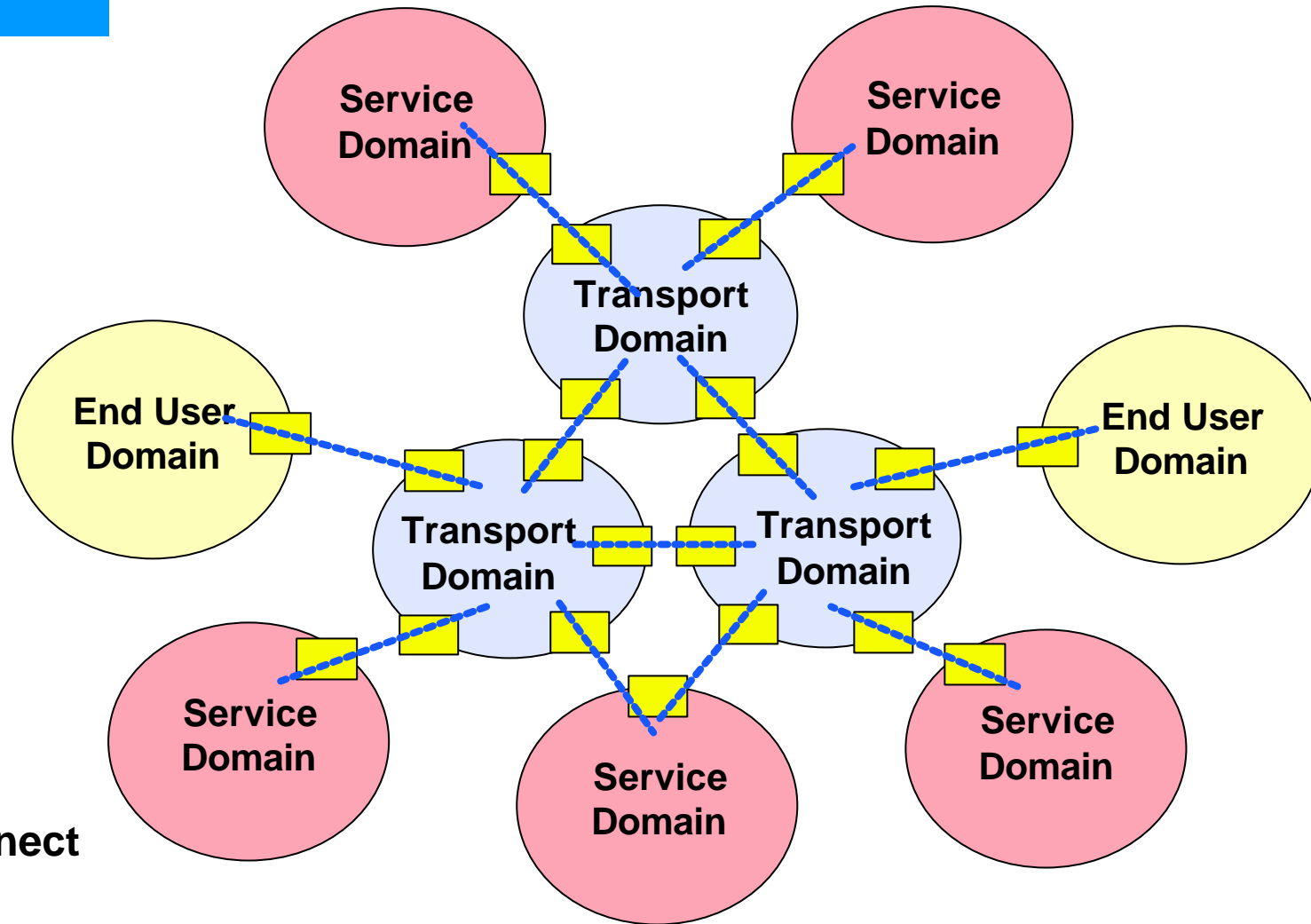Signalling Path
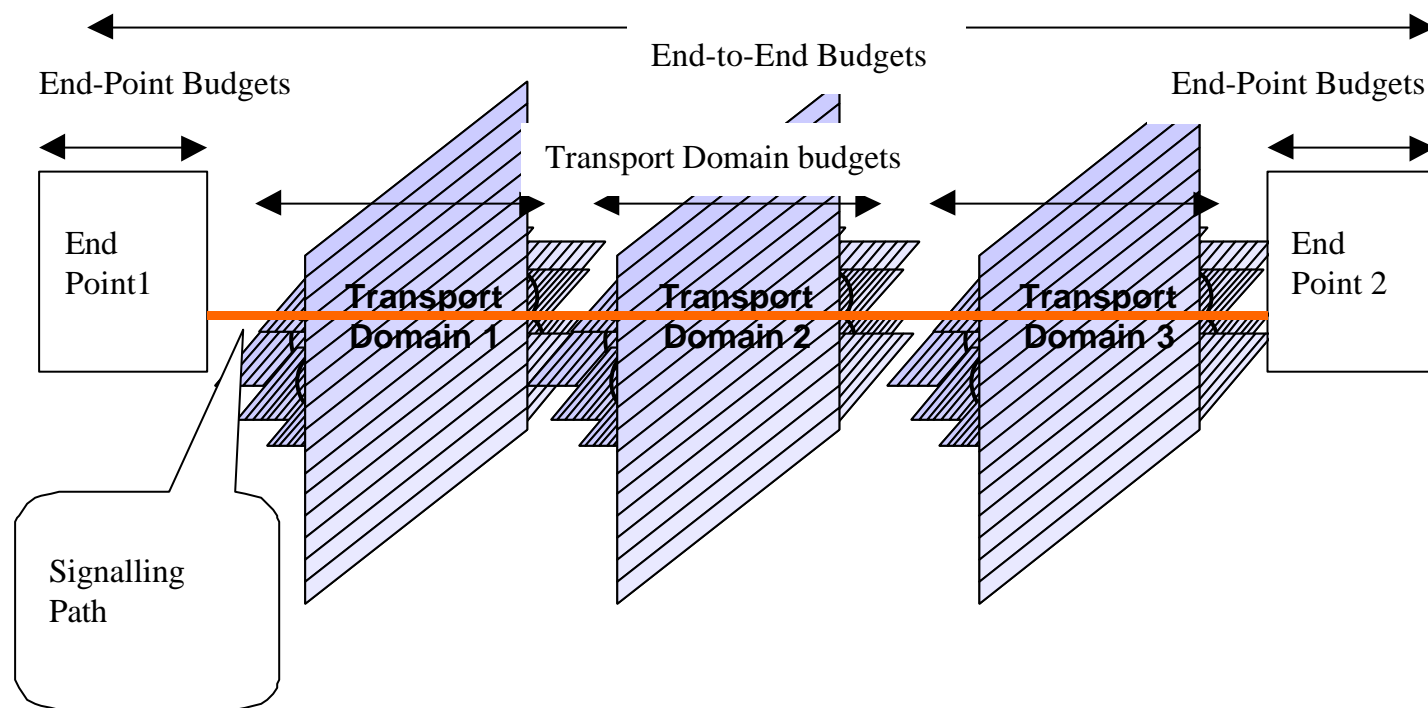
Approach to Allocating QoS Budgets

- The QoS Service Class requested by the End User is translated into a set of End-to-end QoS Parameter Budgets by the initiating Service Provider.

- End-to-end QoS budgets are allocated by the initiating Service Provider.

- The initiating Service Provider negotiates transport QoS budgets, domain by domain, with Network Operators and other Service Providers.

- The initiating Service Provider is reponsible for achieving the end to end QoS budget.

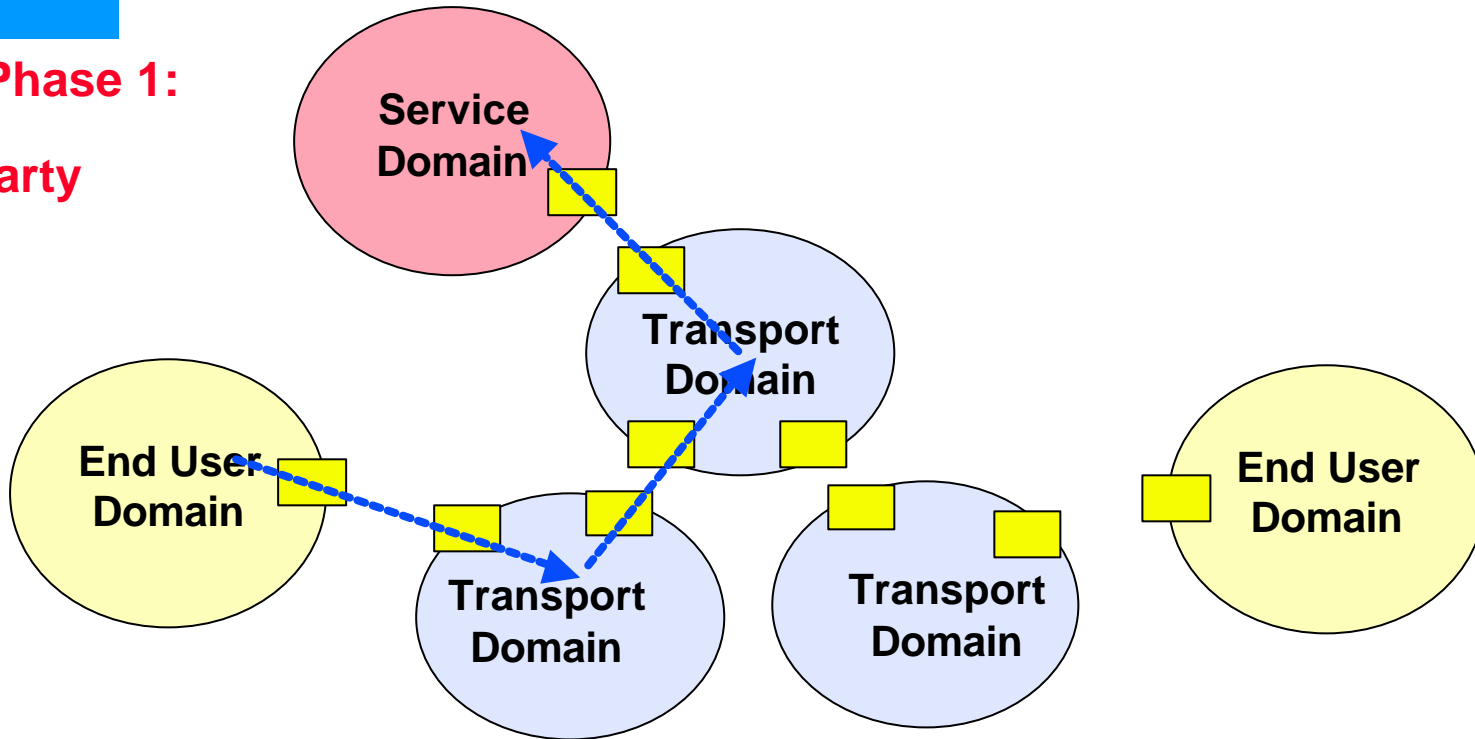# Conventional Approach

Domain InterConnection

ICF

InterConnect Function

QoS Bearer Set-Up (1)

Phase 1:

Calling party to ITSP

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

------ **Call Set-Up**

QoS Bearer Set-Up (2)

Phase 2:

ITSP to
Called party

Service
Domain

Transport
Domain

End User
Domain

Transport
Domain

Transport
Domain

End User
Domain

ICF
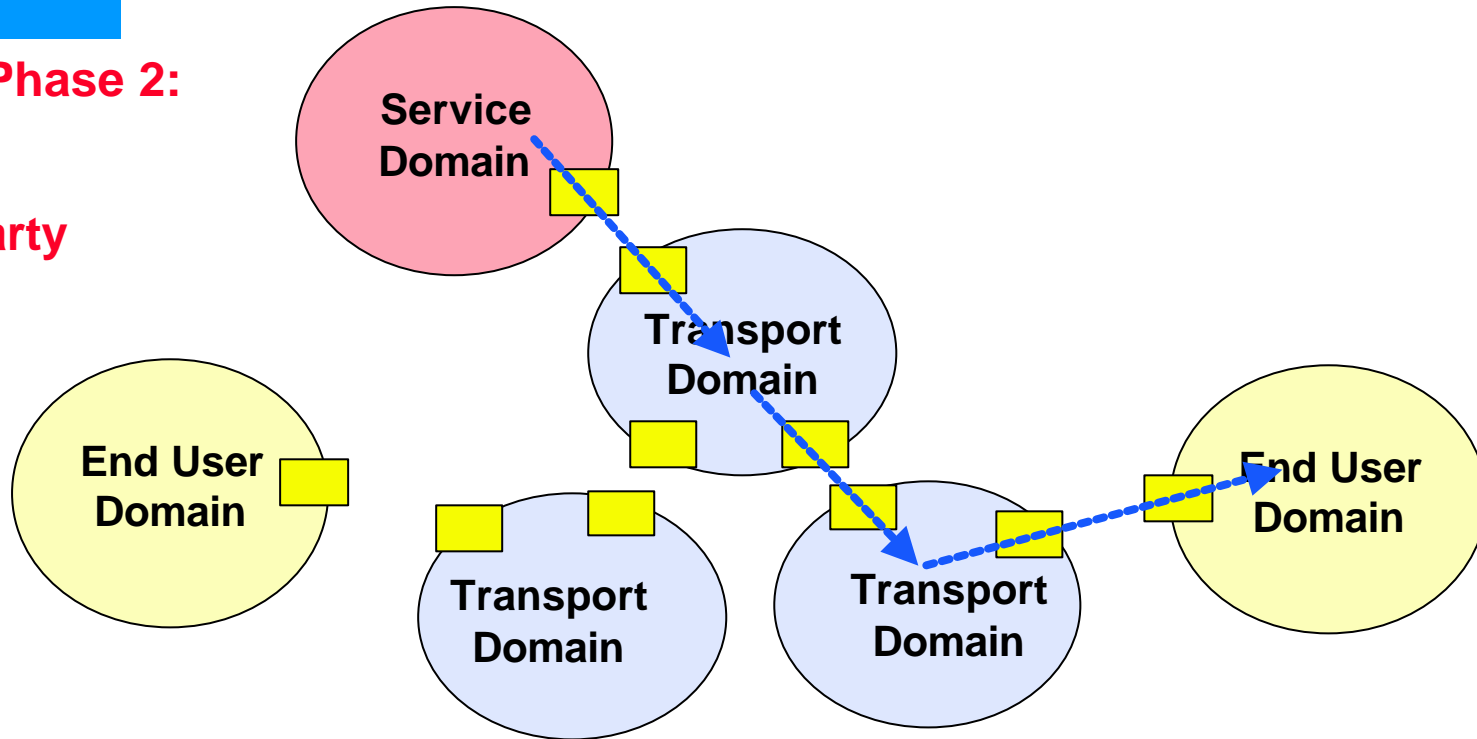
InterConnect
Function

◄------ Call Set-Up

QoS Bearer Set-Up (3)

Phase 3:
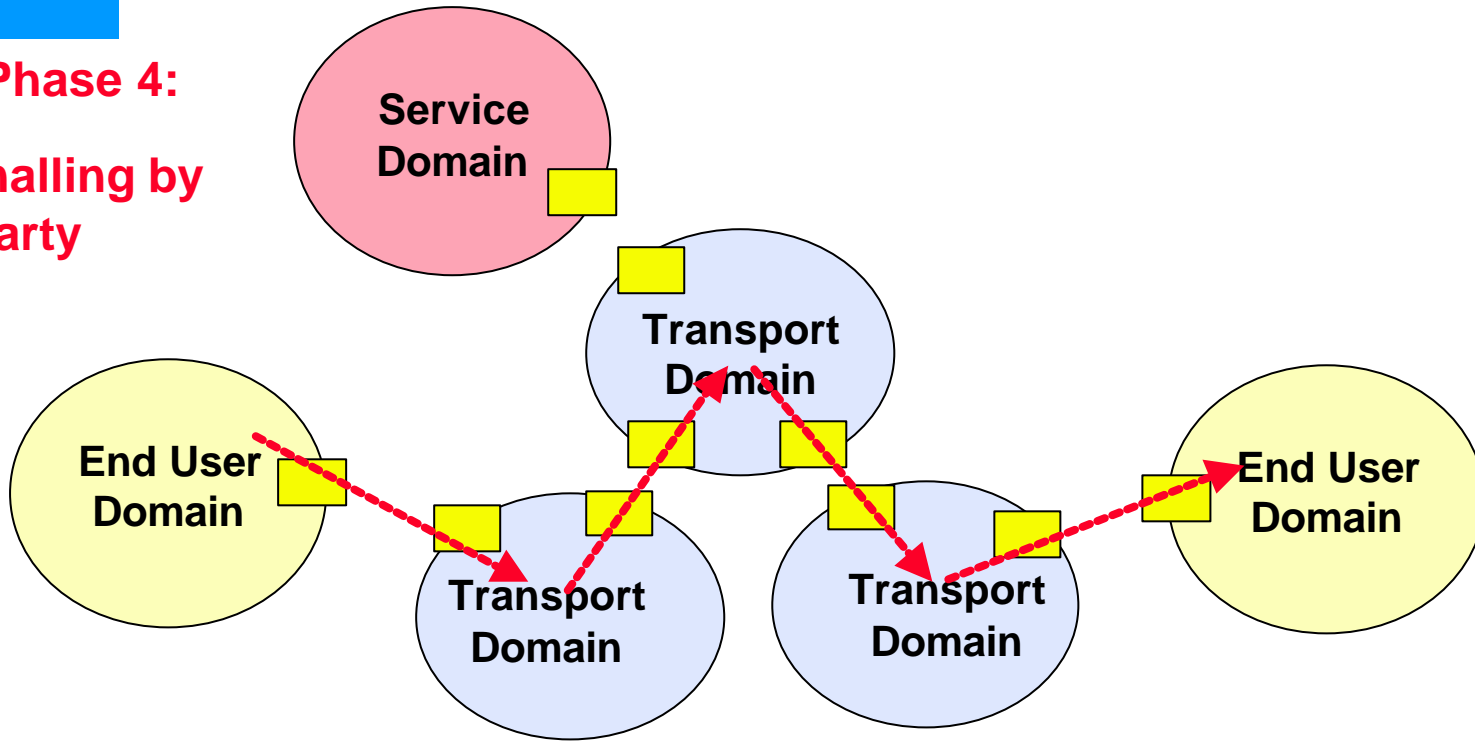
Confirmation by ITSP to Calling & Called parties

Service Domain

Transport Domain

Transport Domain

Transport Domain

End User Domain

End User Domain

ICF
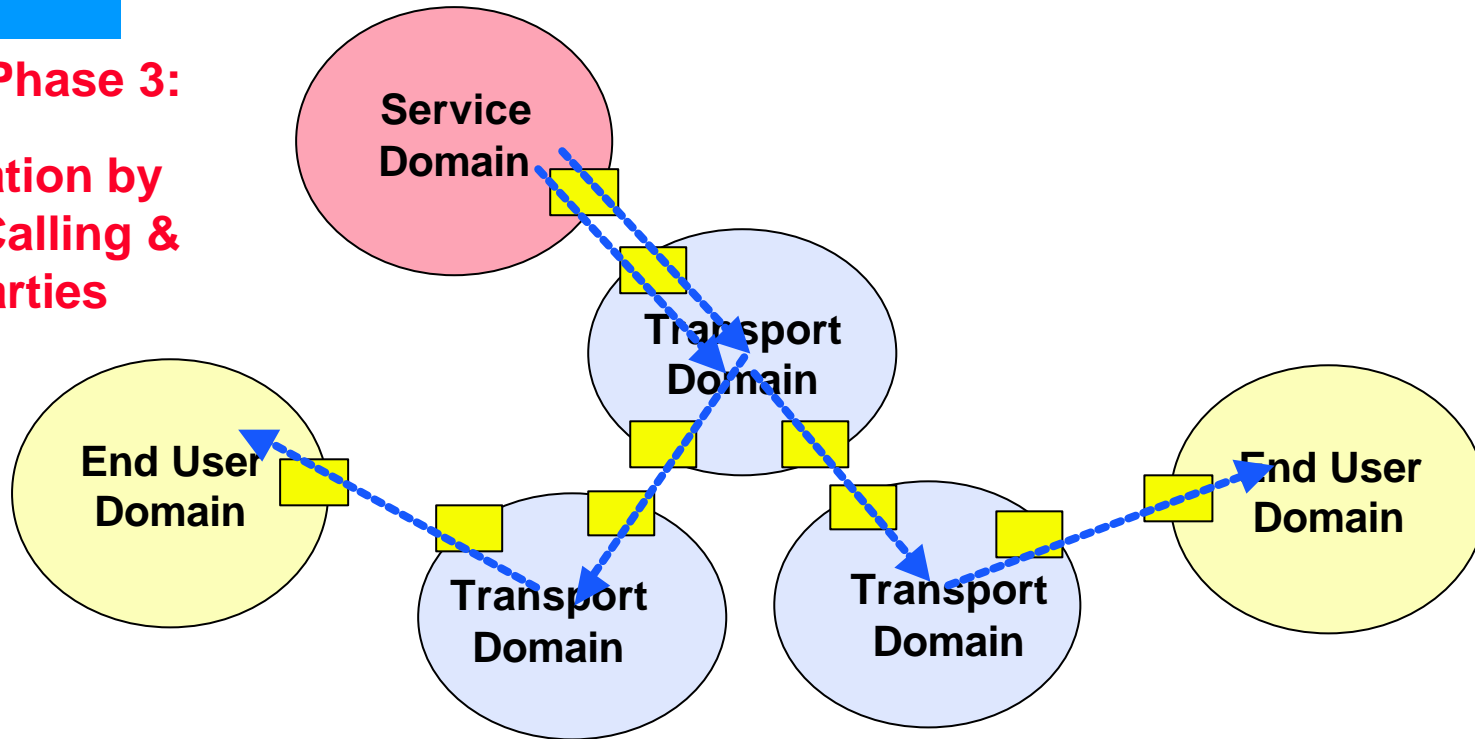
InterConnect Function

------ **Call Set-Up**

QoS Bearer Set-Up (4)

Phase 4:

QoS Signalling by Calling party

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

- - - - - **QoS Signalling**

QoS Bearer Set-Up (6)

Phase 5:

**Media Flow
Established**

Service
Domain

Transport
Domain

Transport
Domain

Transport
Domain

End User
Domain

End User
Domain

ICF
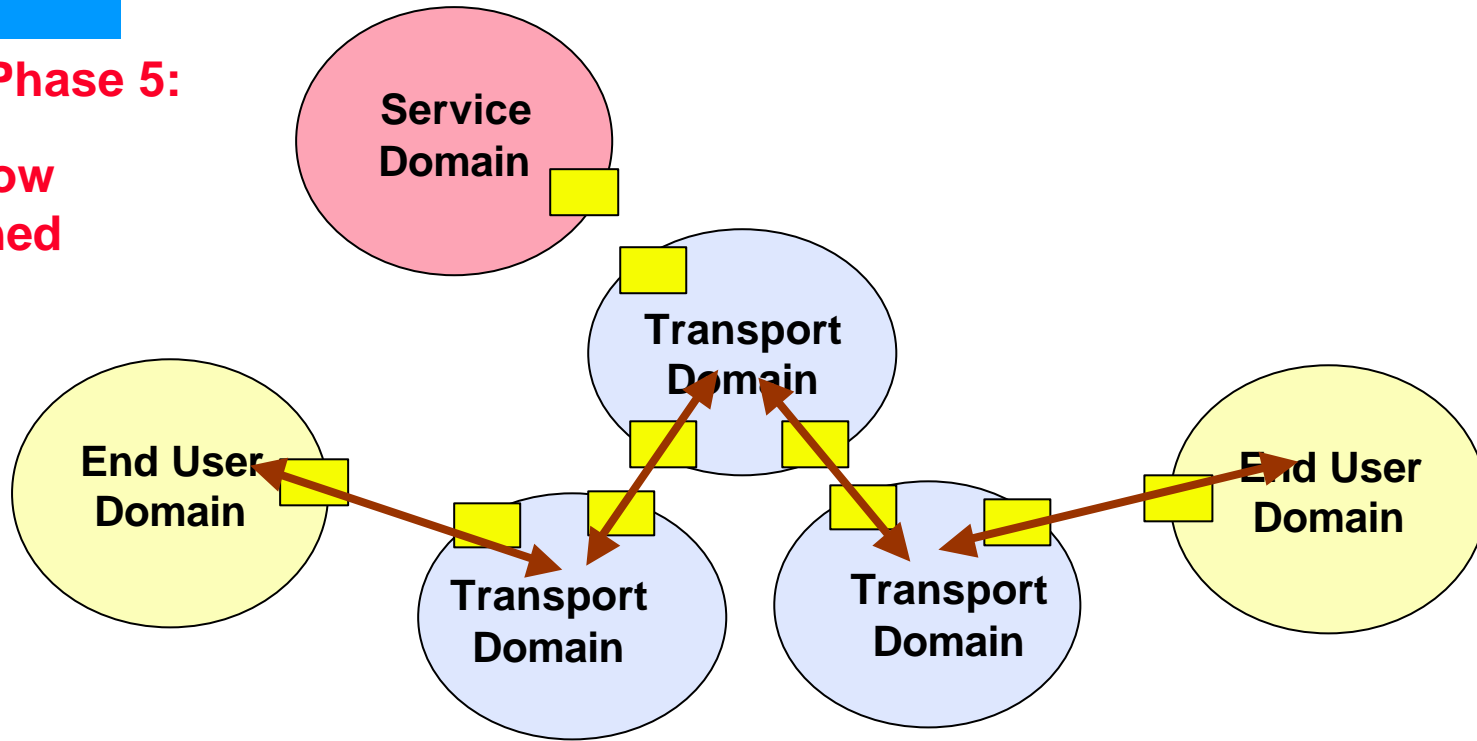
**InterConnect
Function**

← → **Media Flow**

← - - - - **Call Set-Up**

← - - - - **QoS Signalling**

Problems with this Approach

- Transport domains may support different QoS mechanisms and policies.

- Who owns the end to end picture?

- No mechanism to select transport domain on basis of QoS levels supported. c.f choice of alternative long distance carriers.

- QoS messages are not signalled to the service provider - how can he control the QoS levels offered?

- Need a business model for supplying and charging for QoS

Current Work - Imperatives

NEED

- A new approach.

- An end to end QoS architecture.

- Domain by domain control.

- A model that allows and supports charging for QoS.
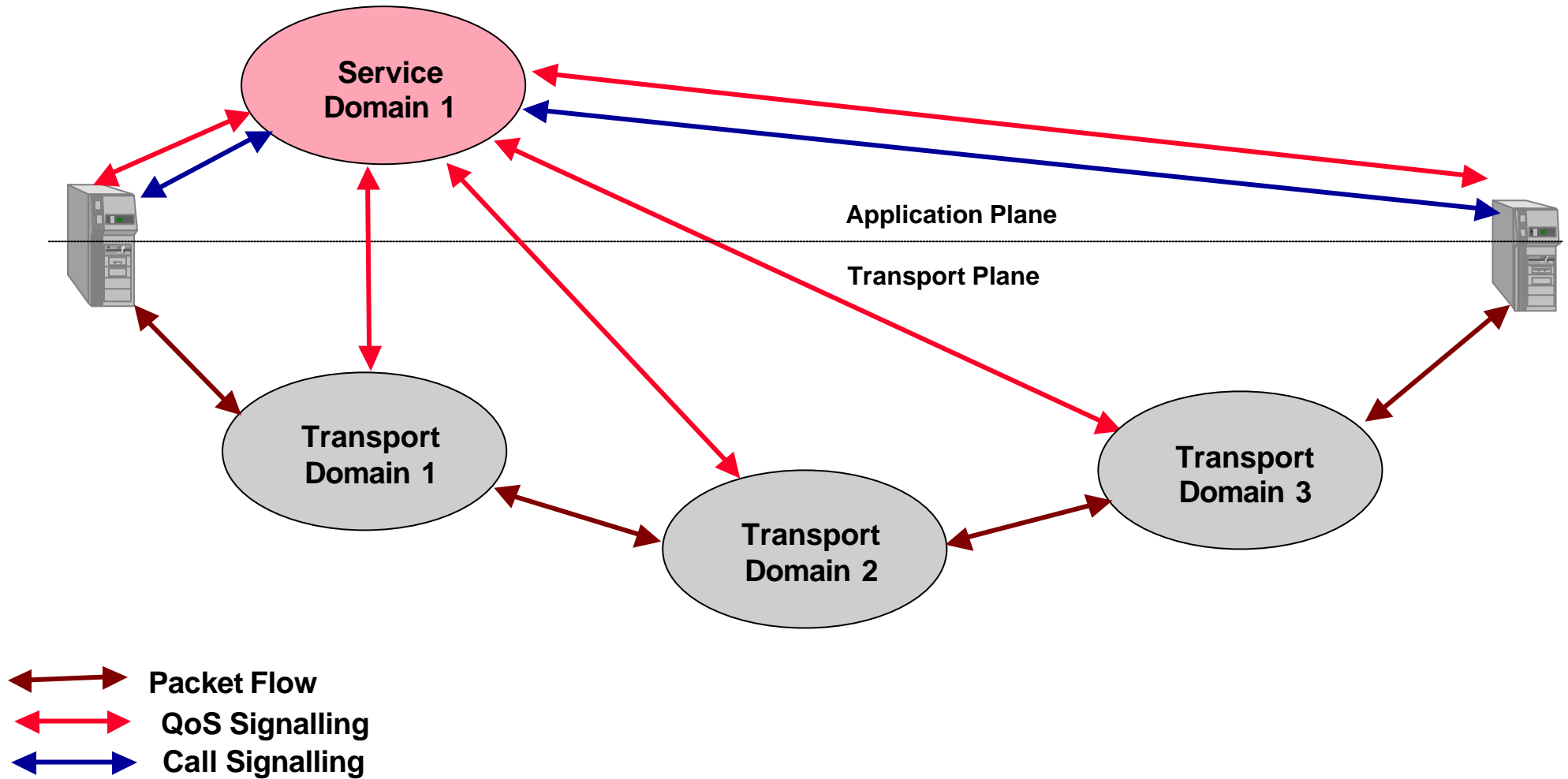
Application Controlled Approach

Two Alternative Business Models

SERVICE PROVIDER ROUTED

- Clearing House Model

- Service Providers determine sequence of networks through which flows pass.

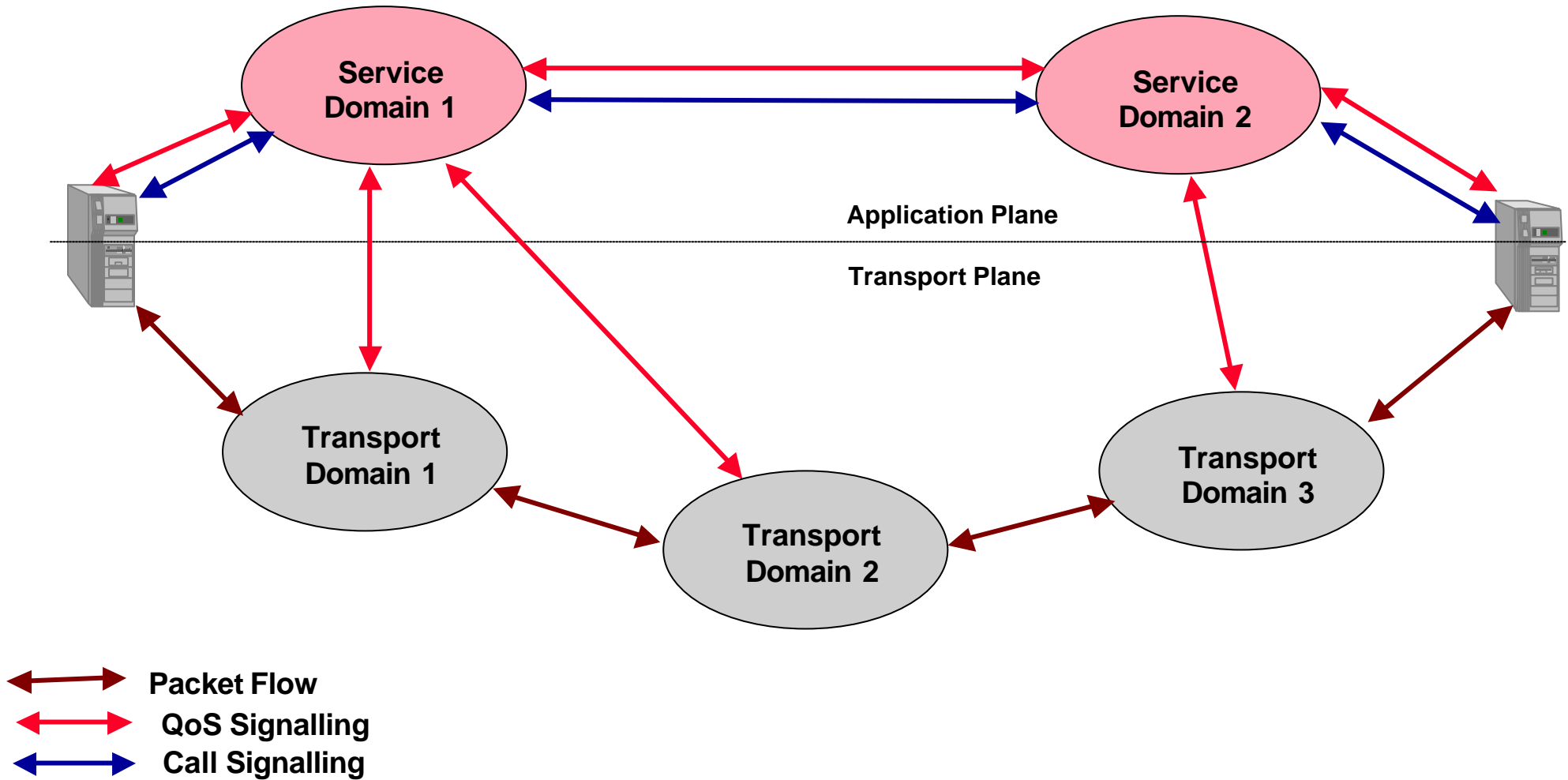- Service Providers have series of SLAs with Network Operators.

Service Provider Routed Model (1)

ITU

Service Domain 1

Transport Domain 1

Transport Domain 2

Transport Domain 3

Application Plane

Transport Plane

Packet Flow

QoS Signalling

Call Signalling

Service Provider Routed Model (2)

Workshop on QoS and user-perceived transmission quality in evolving networks
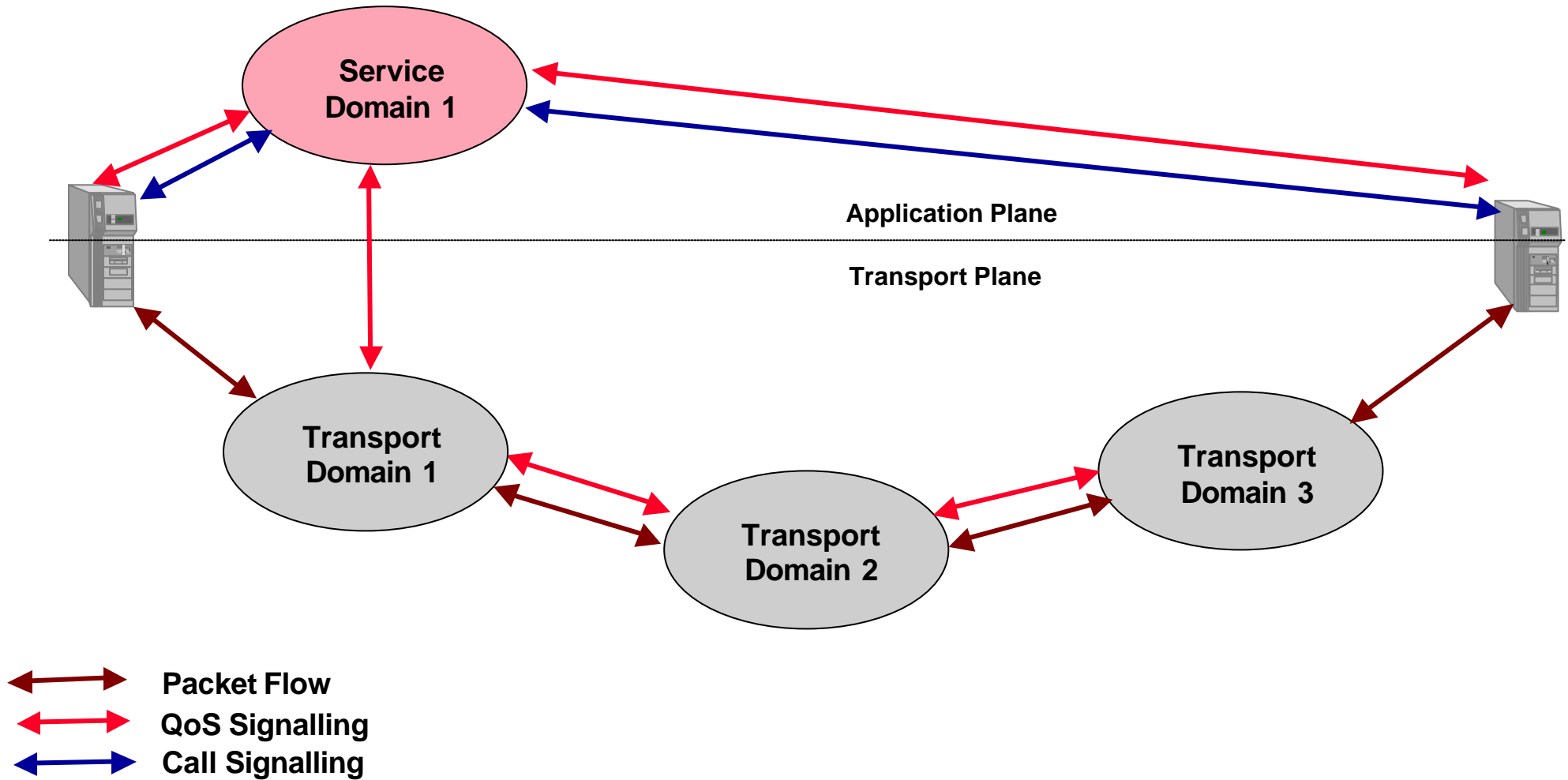
Two Alternative Business Models

NETWORK OPERATOR ROUTED

- Service Provider has SLA with Local Network Operator

- Network operators determine sequence of networks through which flows pass.

- Network Operators have SLAs among themselves.
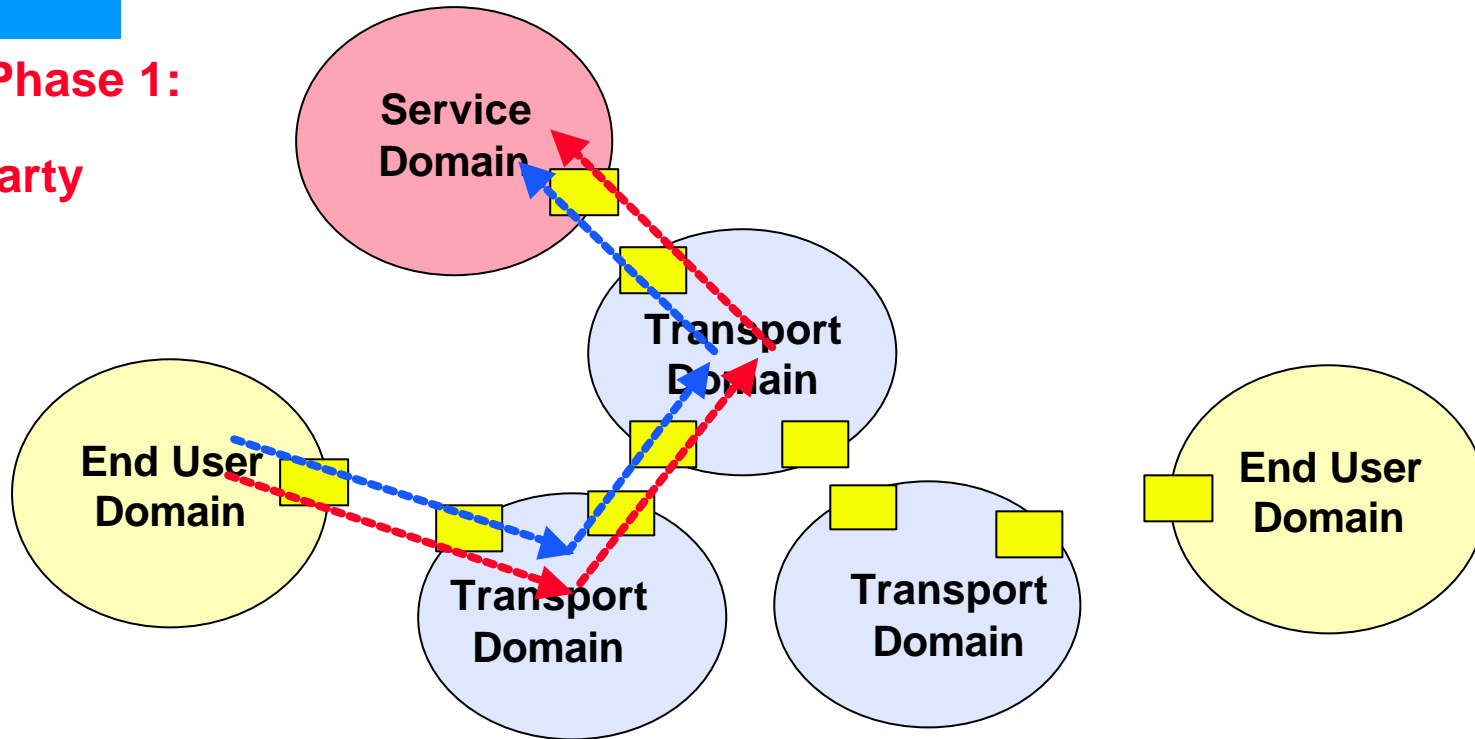
Network Operator Routed Model

Service Domain 1

Application Plane

Transport Plane

Transport Domain 1

Transport Domain 2

Transport Domain 3

Packet Flow

QoS Signalling

Call Signalling

Workshop on QoS and user-perceived transmission quality in evolving networks

QoS Bearer Set-Up (2)
Service Provider Routed

Phase 2:

Resource Reservation in TD1

Service Domain

TRM

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

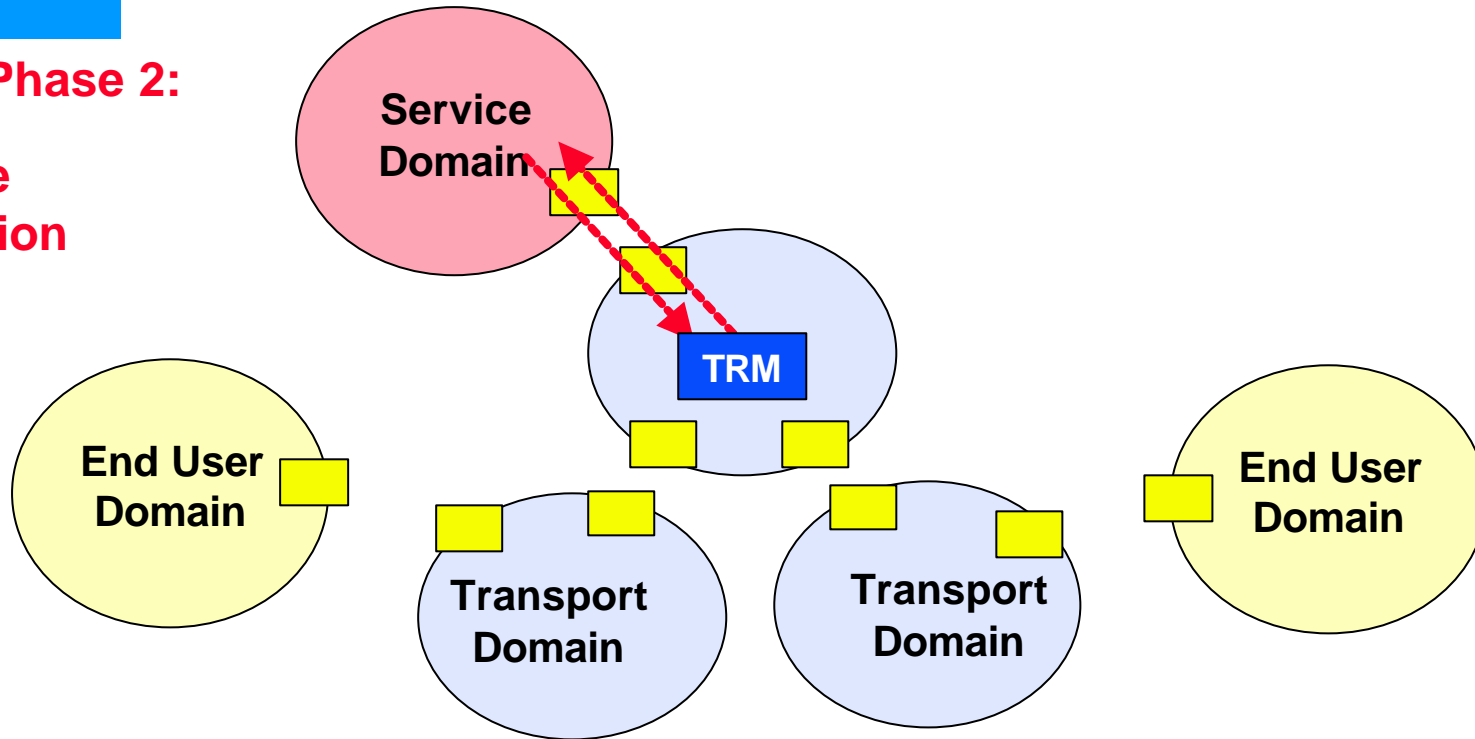**InterConnect Function**

TRM

Transport Resource Manager

Call Set-Up

QoS Signalling

QoS Bearer Set-Up (2)
Service Provider Routed

Phase 2:

Resource Reservation in TD2

Service Domain

Transport Domain

End User Domain

TRM

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

TRM

Transport Resource Manager

Call Set-Up

QoS Signalling

QoS Bearer Set-Up (2)
Service Provider Routed

Phase 2:

Resource Reservation in TD3

Service Domain

Transport Domain

End User Domain

Transport Domain

TRM

End User Domain

ICF

InterConnect Function

TRM

Transport Resource Manager

Call Set-Up

QoS Signalling

QoS Bearer Set-Up (3)
Service Provider Routed

Phase 3:

ITSP to Called party

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF
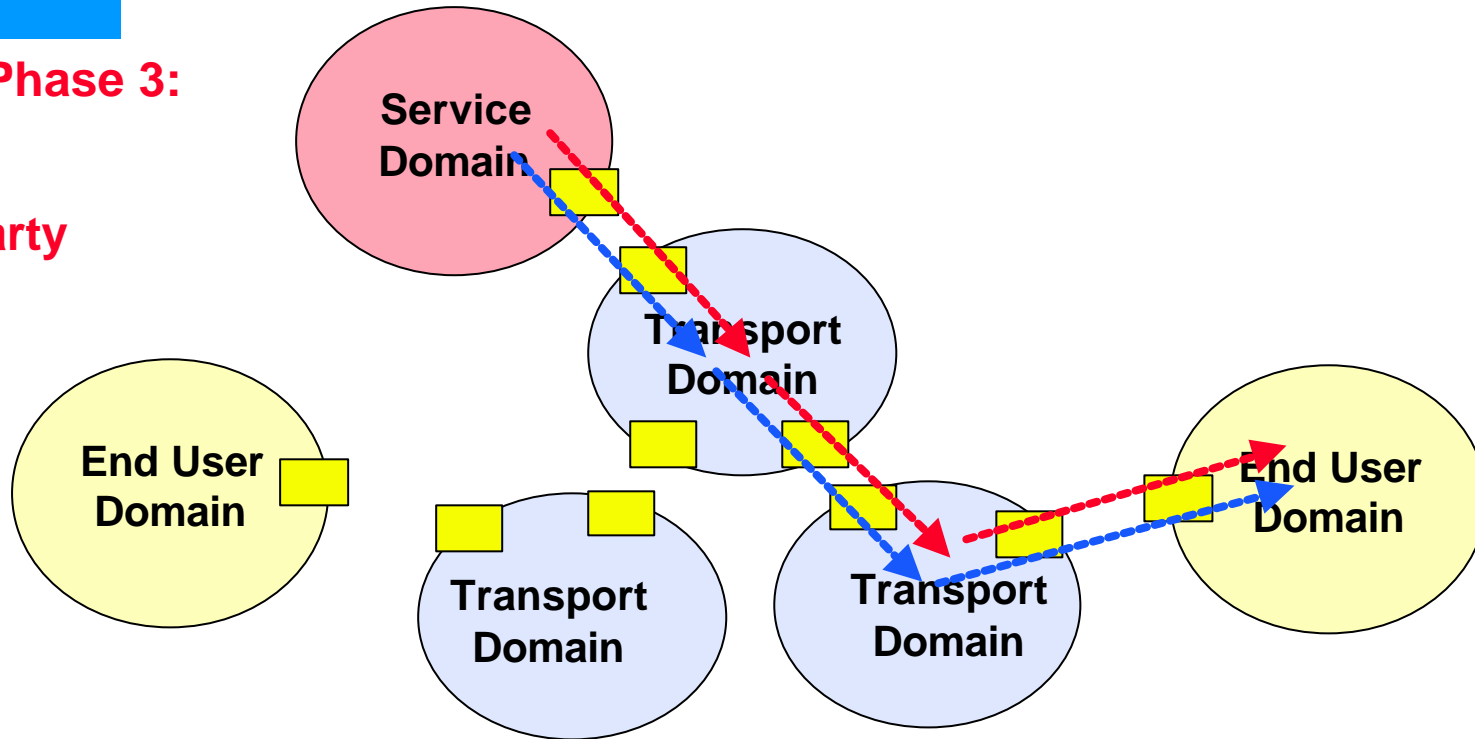
InterConnect Function

- - - - -► **Call Set-Up**
- - - - -► **QoS Signalling**

QoS Bearer Set-Up (4)
Service Provider Routed

Phase 4:

Set-Up of TD1, TD2 & TD3 by ITSP

Service Domain

Transport Domain

End User Domain

Transport Domain

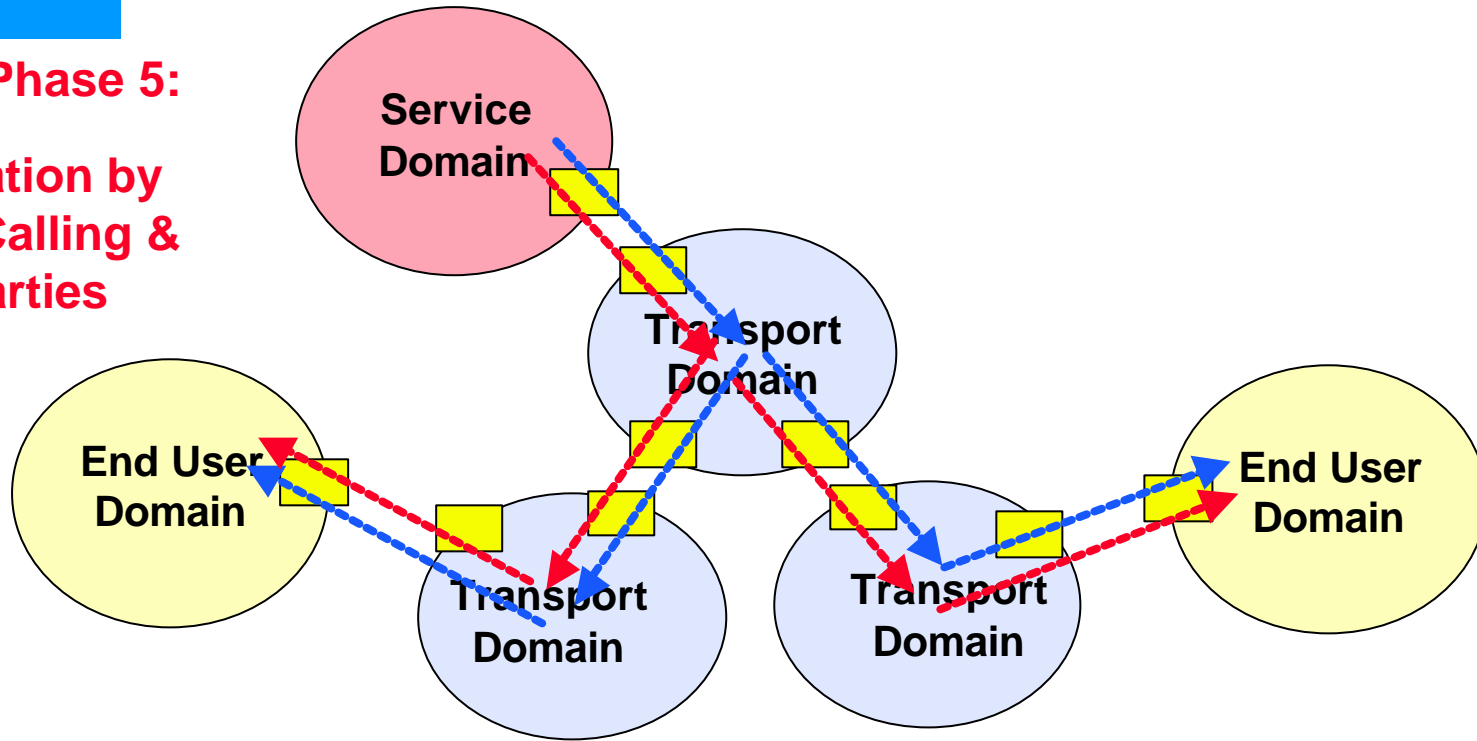Transport Domain

End User Domain

ICF
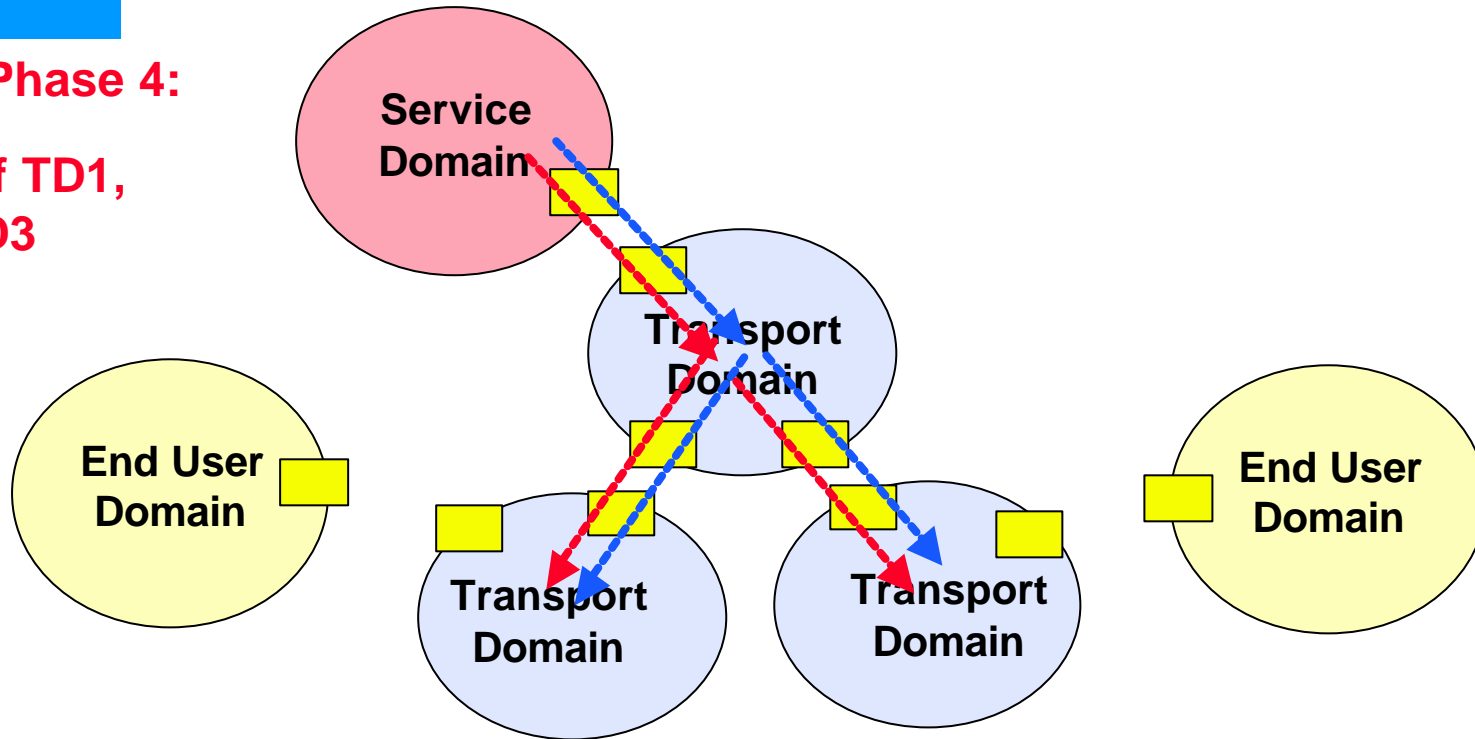
InterConnect Function

Call Set-Up
QoS Signalling

QoS Bearer Set-Up (5)
Service Provider Routed

Phase 5:

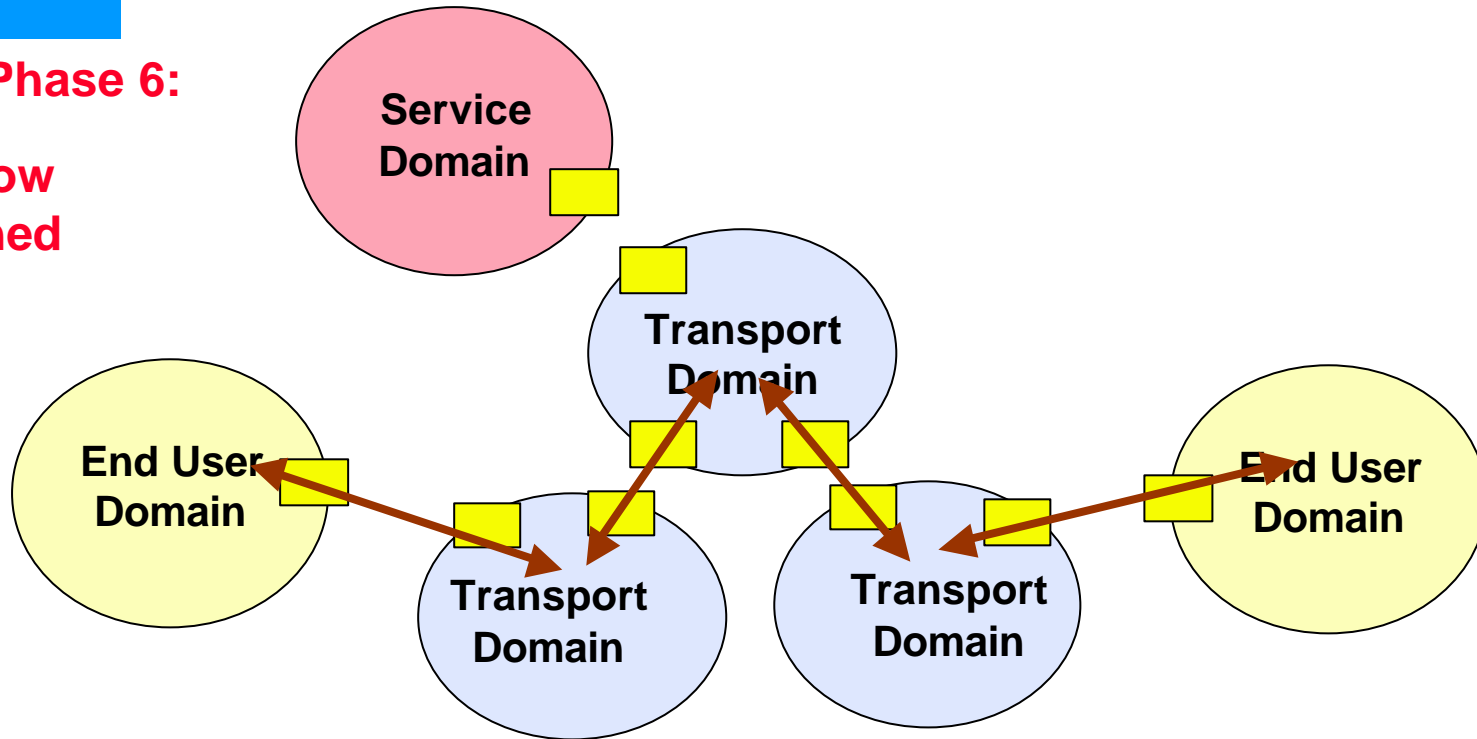Confirmation by ITSP to Calling & Called parties

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

- - - - ► Call Set-Up
- - - - ► QoS Signalling

QoS Bearer Set-Up (6)
Service Provider Routed

Phase 6:

Media Flow Established

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function
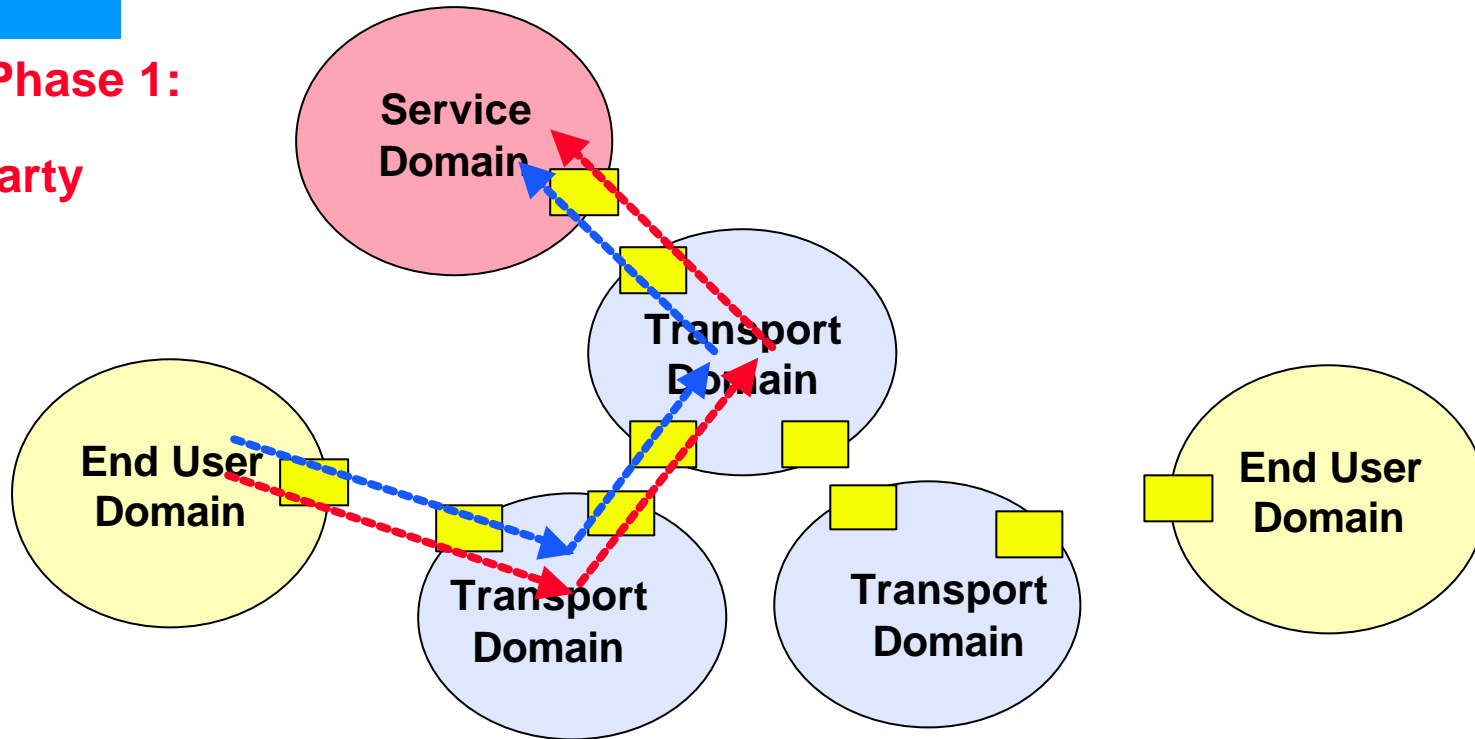
Media Flow

Call Set-Up

QoS Signalling

QoS Bearer Set-Up (1) Network Operator Routed
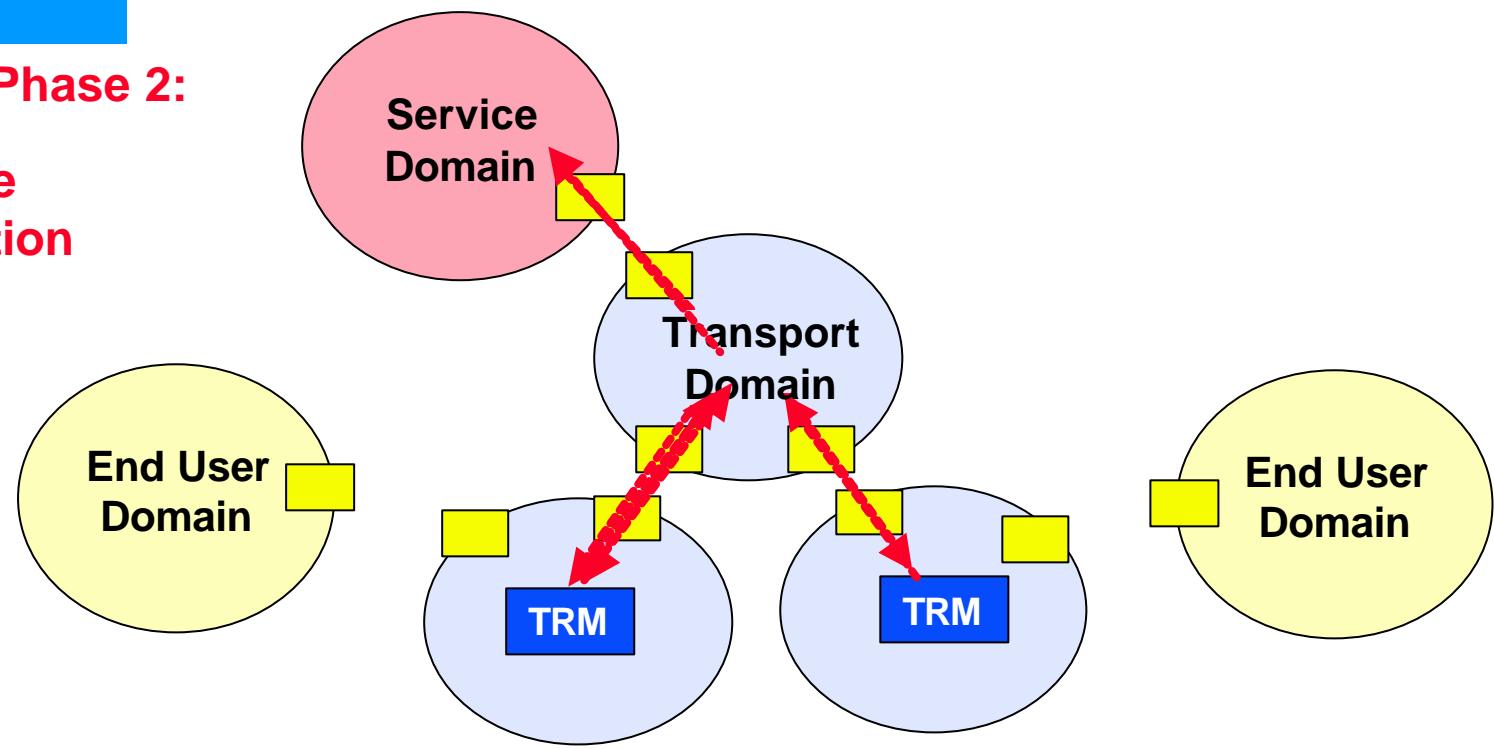
Phase 1:

Calling party to ITSP

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

Call Set-Up
QoS Signalling

QoS Bearer Set-Up (2)
Network Operator Routed

Phase 2:

Resource Reservation

Service Domain

Transport Domain

End User Domain

End User Domain

TRM

TRM

ICF

InterConnect Function

TRM

Transport Resource Manager

Call Set-Up

QoS Signalling

QoS Bearer Set-Up (3)
Network Operator Routed

Phase 3:

ITSP to Called party

Service Domain

Transport Domain

End User Domain

Transport Domain

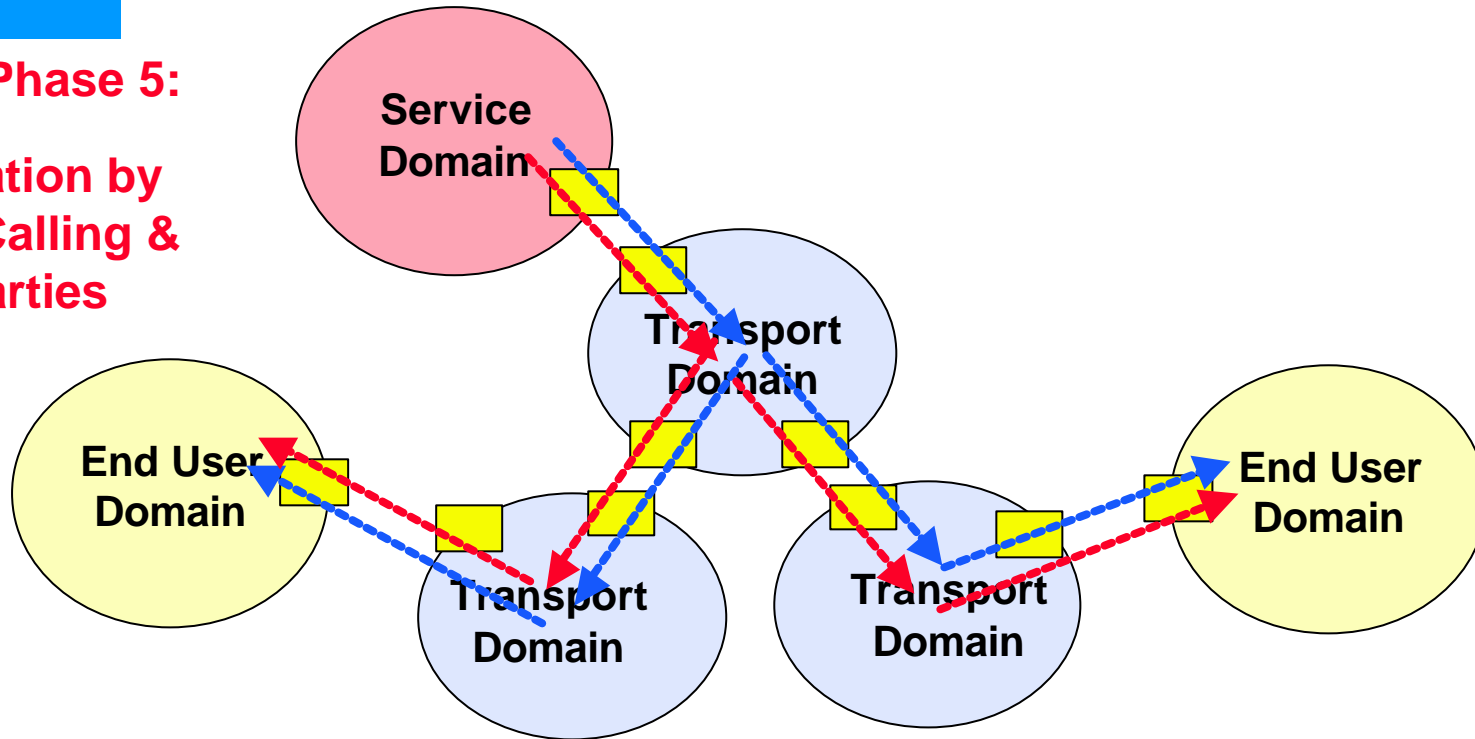Transport Domain

End User Domain

ICF

InterConnect Function

Call Set-Up
QoS Signalling

QoS Bearer Set-Up (5)
Network Operator Routed

Phase 5:

Confirmation by ITSP to Calling & Called parties

Service Domain

Transport Domain

End User Domain

Transport Domain

Transport Domain

End User Domain

ICF

InterConnect Function

- - - → Call Set-Up
- - - → QoS Signalling

QoS Bearer Set-Up (6)
Network Operator Routed

Phase 6:

Media Flow Established

Service Domain

Transport Domain

Transport Domain

Transport Domain

End User Domain

End User Domain

ICF
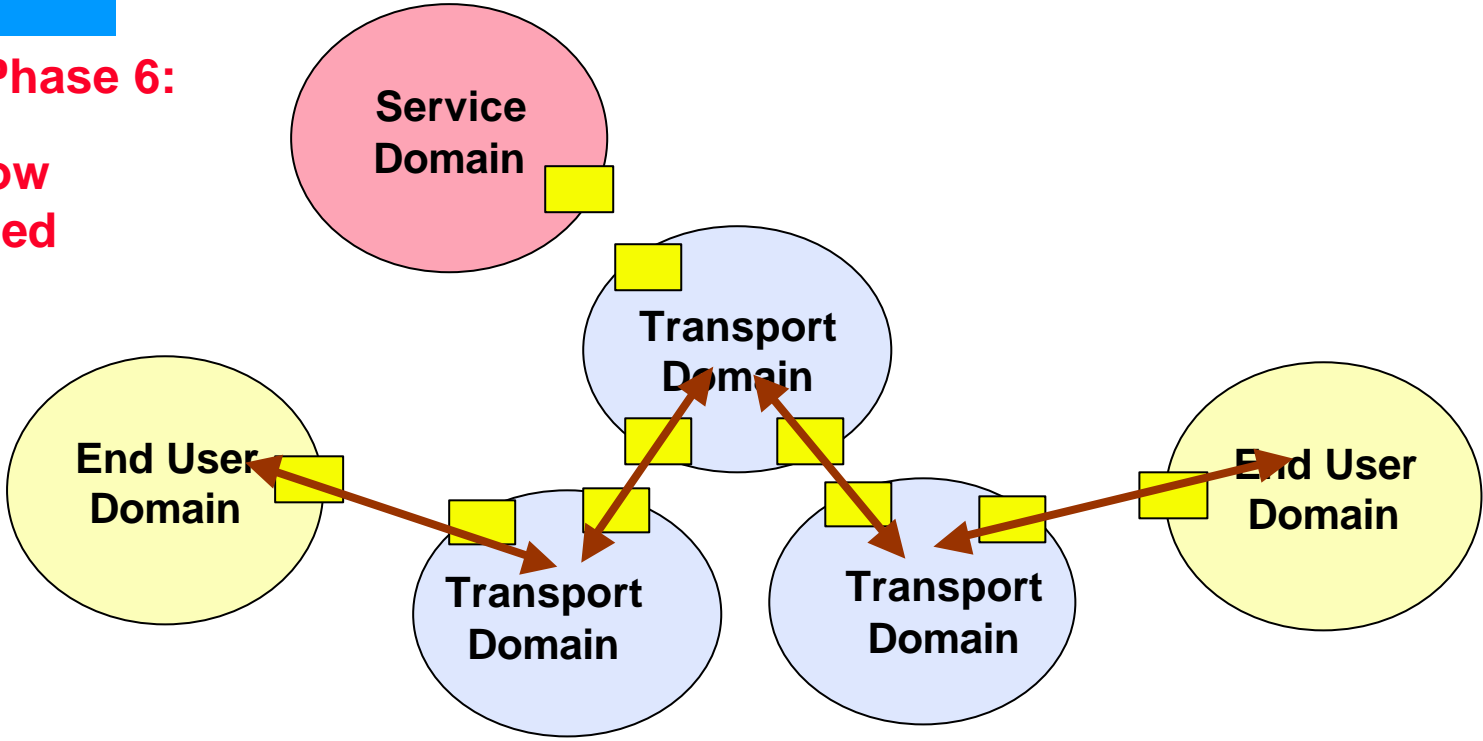
InterConnect Function

Media Flow

Call Set-Up

QoS Signalling

Advantages of the Application Controlled Approach to End-to-end QoS

CLEAR BUSINESS MODEL

- The Application Service Provider is in the driving seat. End-to-end QoS responsibility resides within the Application Plane.

- Required end-to-end QoS levels are established within the Application Plane (Between the End User and Service Provider)

- Transport Domains (Operators) provide a QoS service to the associated Service Domains (Service Providers). QoS control within a Transport Domain is the responsibility of the Operator of that domain

Advantages of the Application Controlled Approach to End-to-end QoS (Cont)
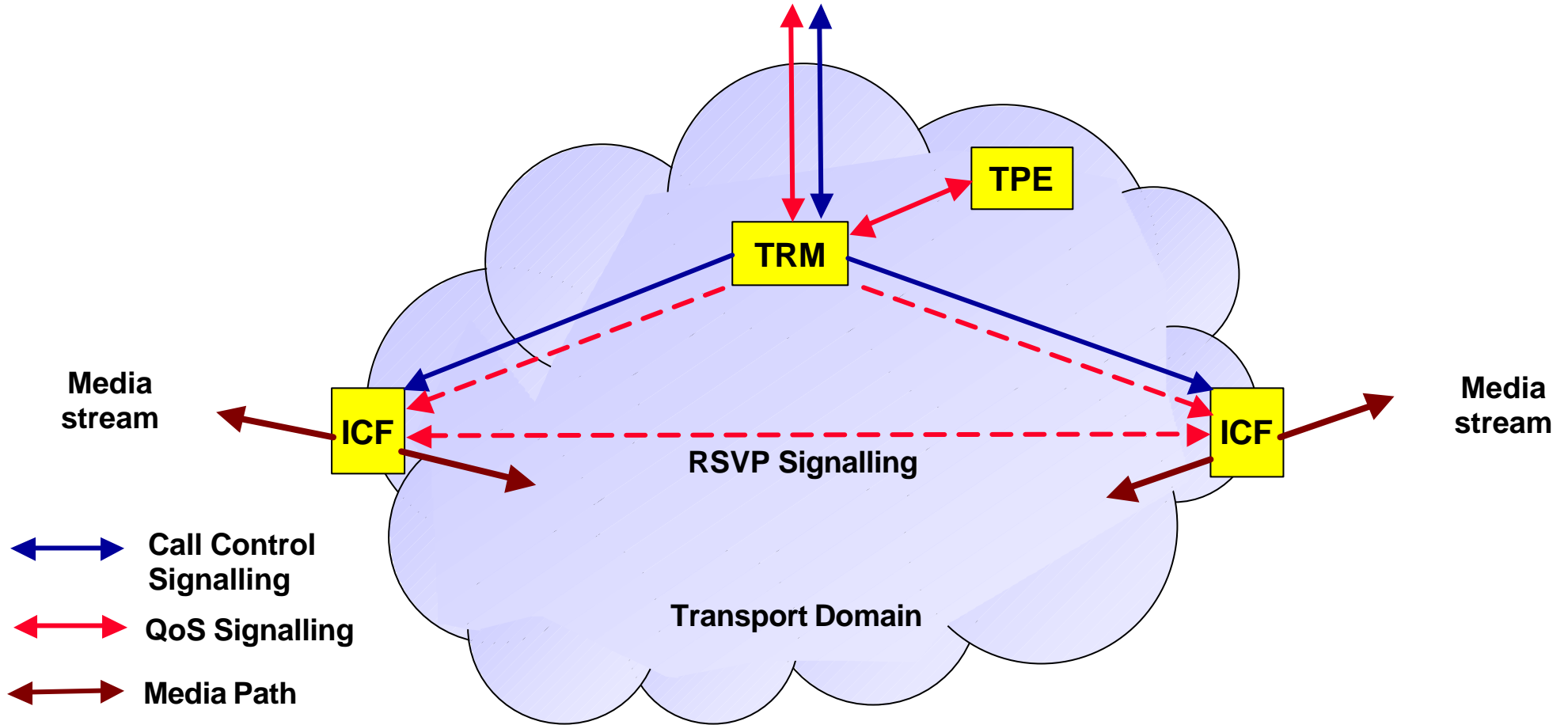
OTHER ADVANTAGES

- A common interface can be defined between a Transport Domain and its associated Service Domain even though different QoS mechanisms may be present within the Transport Plane

- No QoS information need be exchanged between the End User and Network Operator

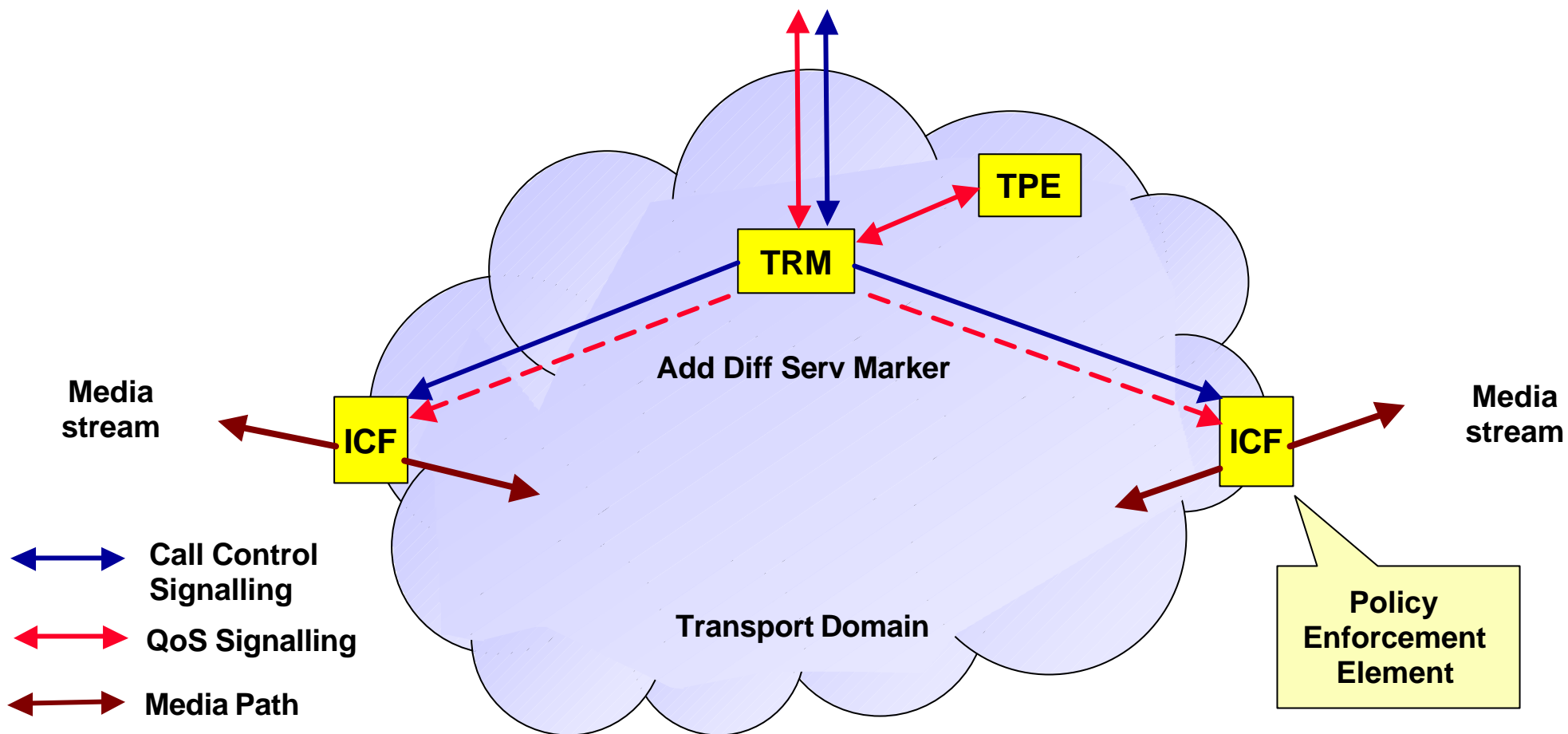- Application Controlled Firewalls and NATS can be accommodated

RSVP Example

QoS Signalling & Addressing - from Application Plane

TPE

TRM

ICF

ICF

Media stream

Media stream

RSVP Signalling

Transport Domain

Call Control Signalling

QoS Signalling

Media Path

Diff Serv Example

QoS Signalling & Addressing - from Application Plane

TPE

TRM

Add Diff Serv Marker

Media stream

ICF

ICF

Media stream

Call Control Signalling

QoS Signalling

Media Path

Transport Domain

Policy Enforcement Element

Mixed Transport QoS Mechanisms

Service Domain

Service Domain

TD2 (MPLS/ATM)

End User Domain

End User Domain

TD1 (RSVP)

TD3 (DIFFSERV)

Service Domain

Service Domain

Service Domain

ICF

InterConnect Function

Media Flow

Call Set-Up

QoS Signalling

Workshop on QoS and user-perceived transmission quality in evolving networks

SUMMARY

- TIPHON uses an End to End QoS Model.

- Service Quality is established top-down from End-User, via Service Provider(s), to Network Operators .

- End-to-end QoS is the responsibility of the initiating SP.

- TRM and ICF model enables any transport QoS mechanisms to be deployed in the transport plane

- TIPHON approach not constrained to a single business model.