http://www.mescal.org

The IST MESCAL project

(Management of End-to-end Quality of Service across the Internet At Large)

November 2002 to April 2005

Project partners

- Industrial partners:
  - France Telecom R&D (PM)
  - Thales Research Ltd (P)
  - Algonet SA (P)
- Academics:
  - UCL (P)
  - UniS (P)
- Equipment vendors:
  - Cisco Systems (sponsorship)
  - Alcatel Bell (standardisation)

Project objectives

- Basic objective:

> **To specify and validate scalable, incremental solutions that will enable the flexible provisioning of inter-domain QoS across the Internet**

- Project work plan includes:
    - Specification of business models and functional architecture
    - Specification, development and validation of dynamic service management algorithms
    - Routing protocols enhancements for inter-domain traffic engineering
    - Integration of IPv6 and multicast

From TEQUILA to MESCAL

- TEQUILA addressed mainly *intra-*domain QoS
    - SLSs for customer-ISP interactions
    - service and resource (TE) aspects for edge-to-edge QoS across a single domain
    - inter-domain studies were limited to mechanisms for conveying TE information between domains via BGP NLRI extensions

- MESCAL focuses on *inter-*domain QoS
    - customer-ISP and ISP-ISP interactions
    - service and resource (TE) aspects and interactions across multiple ISPs for inter-domain QoS delivery end-to-end across the Internet

- MESCAL builds on TEQUILA results
    - SLS-based QoS definition
    - service and TE architectures, logic, protocols

Environment and assumptions

- No "Internet God"
  - No global view of the Internet
  - No ASs of the same (or affiliated) administration to offer global Internet coverage
- IP-based networking
  - Diffserv-capable IP networks
  - Different QoS policies per ISP

- Build-on existing, widely accepted/deployed inter- and intra-AS protocols (*e.g.* BGP, OSPF)

- Currently, SLAs between customers and ISPs are given *ONLY* within the geographical span of the ISPs…thus…

MESCAL

MESCAL principles

- Co-operation is required between ISPs
- Inter-domain QoS delivery is NOT a single optimization problem, but a set of them
- Clear distinction between services and resources
- ISP interactions based on widely accepted information templates and related exchange protocols (for services and resources)

MESCAL approach
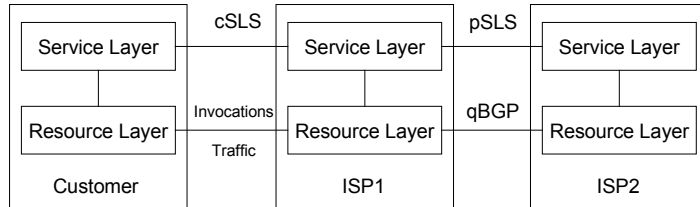
Each ISP to:

1. Engineer the QoS capabilities

Extending QoS capabilities beyond domain, by peering SLSs with neighboring ISPs

QoS-bindings of ISP QoS capabilities with QoS capabilities of peer ISPs

2. Engineer the network

Inter-domain: To select the 'best' neighbor to route Internet traffic to

Intra-domain: To meet the QoS of the established SLSs with customers and peer ISPs
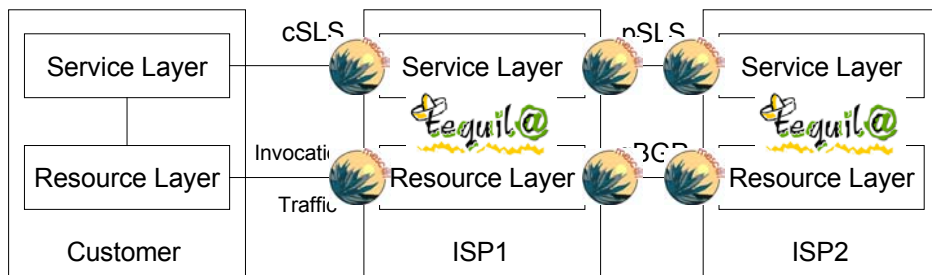
	cSLS		pSLS	
Service Layer		Service Layer		Service Layer
Resource Layer	Invocations	Resource Layer	qBGP	Resource Layer
Customer	Traffic	ISP1		ISP2

Driven by market needs and business objectives

Driven by SLS requirements

MESCAL vs. TEQUILA revisited

	cSLS		pSLS	
Service Layer		Service Layer		Service Layer
		tequil@		tequil@
Resource Layer	Invocation	Resource Layer	qBGP	Resource Layer
Customer	Traffic	ISP1		ISP2

Inter-domain QoS example

Two ASs interconnected
by direct link or through
Internet Exchange Point

Customer 1   ISP/AS1   ISP/AS2   Customer 2

Inter-domain QoS example

Two ASs interconnected
by direct link or through
Internet Exchange Point

Customer 1   ISP/AS1   BGP   ISP/AS2   Customer 2

Routers B and C are
BGP peers. AS2
advertises reachable
destination prefixes,
including customer 2

Inter-domain QoS example

qc1

A   B   BGP   C   D

Customer 1   ISP/A...   ISP/AS2   Customer 2

AS1 applies its preferred
TE method to engineer
QoS class qc1

Inter-domain QoS example

qc1   qc2

A   B   BGP   C   D

Customer 1   ISP/A...   IS...S2   Customer 2

AS...
T...

AS2 applies its own
TE method to engineer
QoS class qc2

Inter-domain QoS example

qc1   qc2

A   B   C   D

BGP
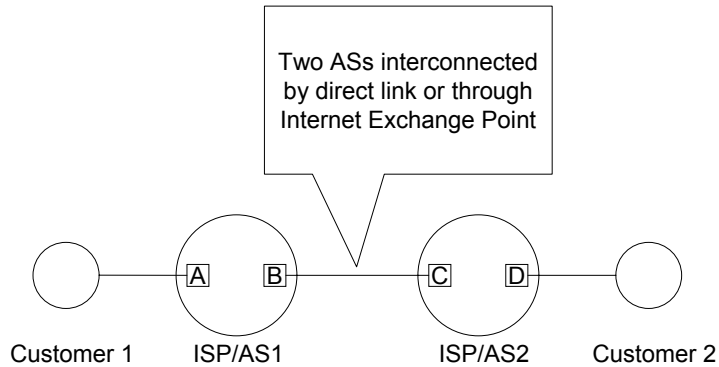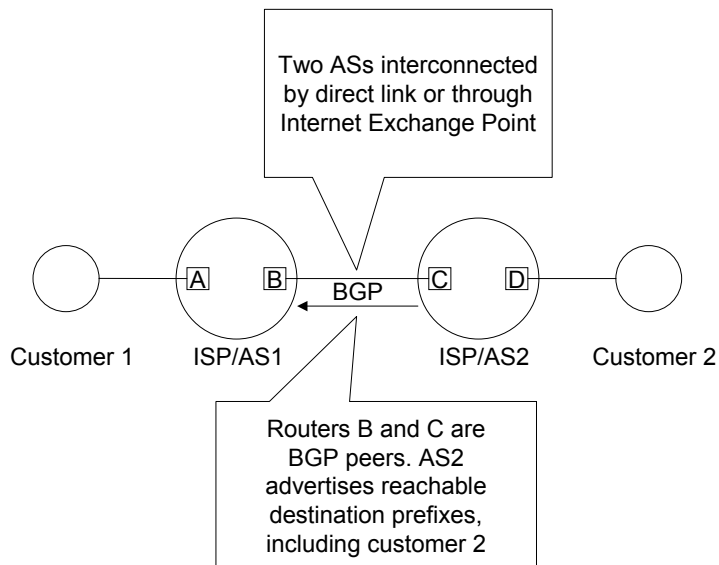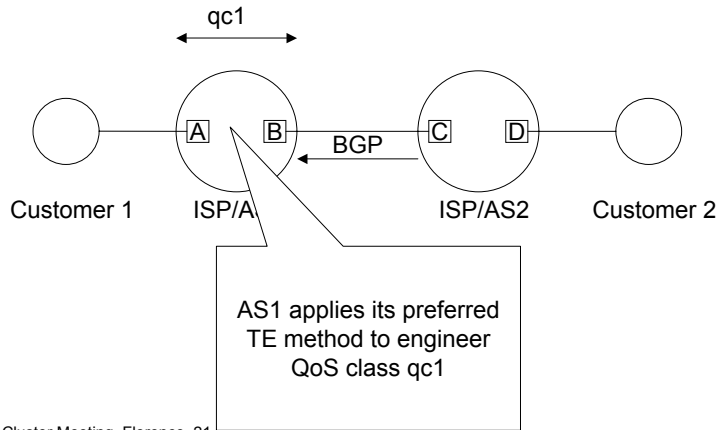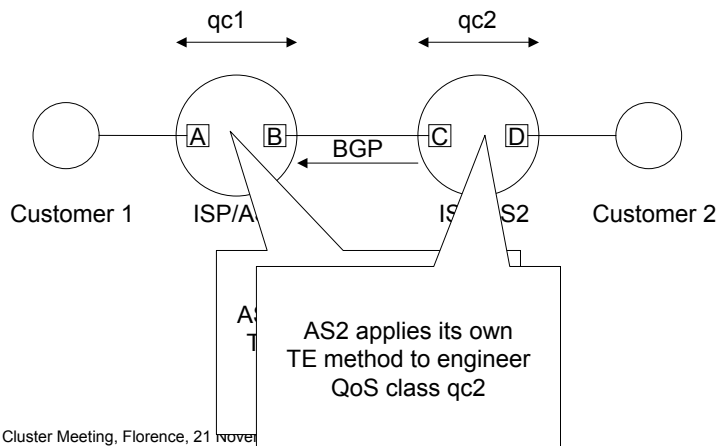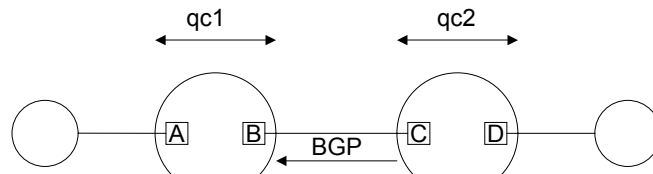
SLAs are required between ISPs and customers (or peer ISPs)
to use other than Best Effort QoS Classes: qc1 or qc2
- quantity of traffic
- topological scope
- quality parameters
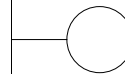- a la TEQUILA SLS template

---

Inter-domain QoS example

ISP1 is aware of ISP2's qc2 capability through,
e.g. InterQoS marketplace.

According to its business objectives, customer
requirements, ISP1 defines an *Inter-domain*
QoS Class, iqc1:

iqc1 = qc1 *op* qc2

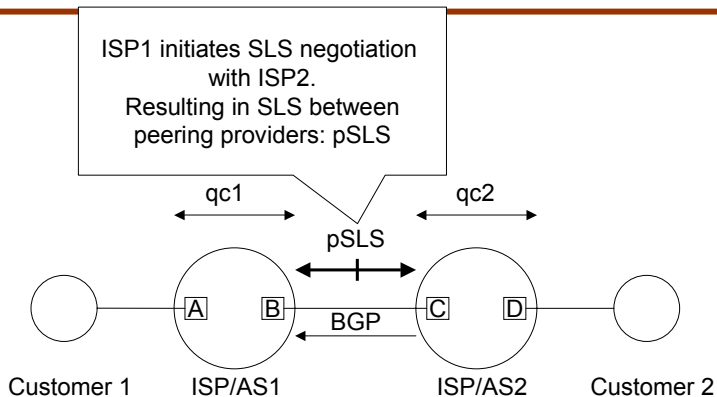(*op*: e.g. *addition* for delay, *minimum* for throughput)

("QoS binding" in MESCAL)

Customer 2

Inter-domain QoS example

ISP1 initiates SLS negotiation with ISP2.
Resulting in SLS between peering providers: pSLS

qc1   pSLS   qc2

A   B   BGP   C   D

Customer 1   ISP/AS1   ISP/AS2   Customer 2

Inter-domain QoS example

Routers in AS1 are updated with QoS based reachability information

Automatic, *distributed* configuration to support business agreement (SLS)

pSLS   qc2

A   B   BGP   C   D

Customer 1   ISP/AS1   ISP/AS2   Customer 2
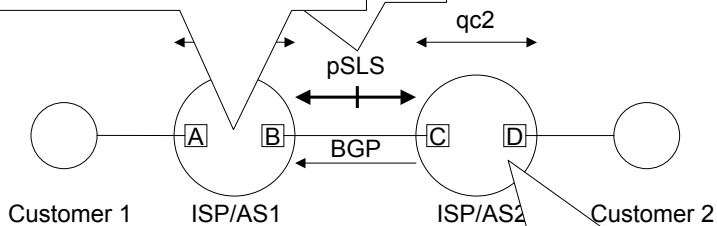
ISP2 may reengineer its network (depending on Resource Provisioning Cycle)
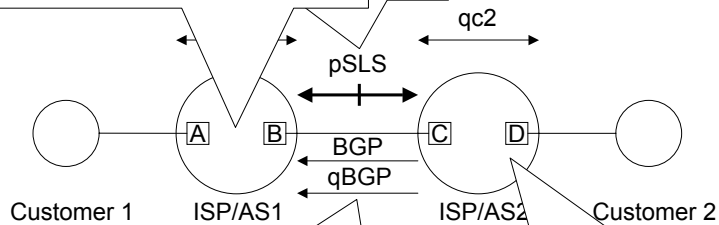
Deploys diffserv traffic conditioner at C

Inter-domain QoS example

Routers in AS1 are updated with QoS based reachability information

Automatic, *distributed* configuration to support business agreement (SLS)

qc2

pSLS

A B   BGP   C D
        qBGP

Customer 1   ISP/AS1   ISP/AS2   Customer 2

AS2 advertises QoS capabilities to destinations defined in pSLS to AS1.

QoS extensions to BGP4 (qBGP)

...reengineer its network ...n Resource Provisioning Cycle)

...erv traffic conditioner at C

Inter-domain QoS example

iqc1

qc1   qc2

pSLS

A B   BGP   C D
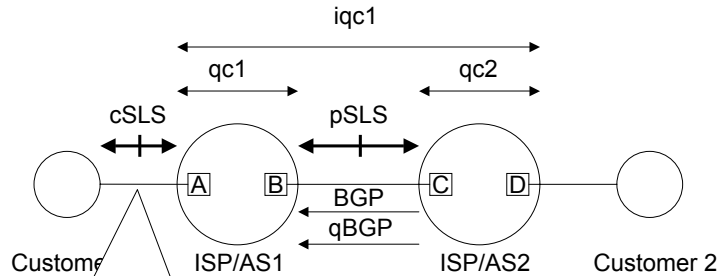   qBGP

Customer 1   ISP/AS1   ISP/AS2   Customer 2
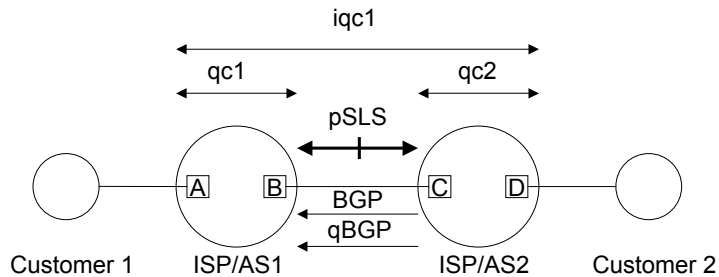
ISP1 is now in a position to offer inter-domain QoS Class iqc1 to its customers in addition to intra-domain QoS Class qc1 and BE services

Inter-domain QoS example

iqc1

qc1 qc2

cSLS pSLS

A B C D

BGP
qBGP

Custome ISP/AS1 ISP/AS2 Customer 2

Customer 1 may now negotiate with
ISP1 for a cSLS based on QoS Class
iqc1 to customer 2

Inter-domain QoS example

iqc1

qc1 qc2

cSLS pSLS

A B C D

BGP
qBGP

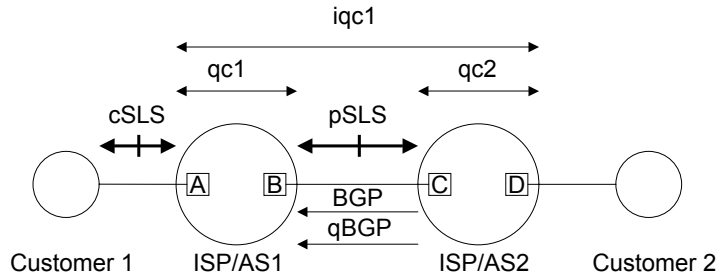Customer 1 IS ISP/AS2 Customer 2
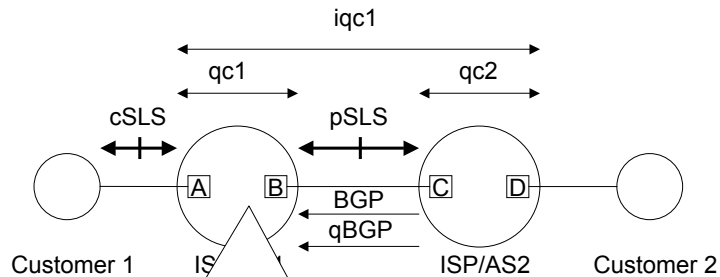
ISP1 may reengineer its network to
accommodate the new cSLS
(depending on its Resource Provisioning
Cycle)

Deploys diffserv traffic conditioner at A
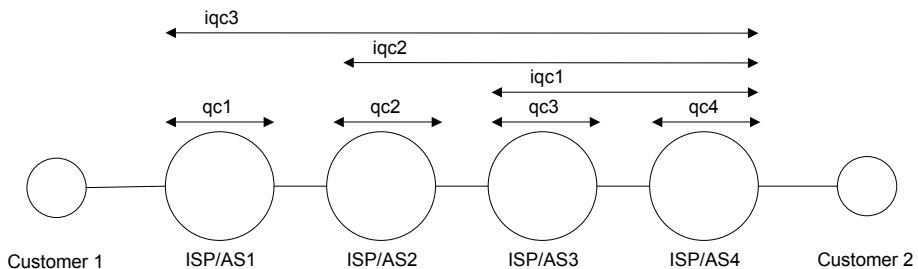
Inter-domain QoS example

AS1 may now forward packets from customer 1 towards customer 2
via AS2 meeting QoS requirements of cSLS with customer 1
(must assume AS2 fulfils its pSLS)

Example 2: >2 ASs/ISPs

Example 3: alternative QoS bindings

200ms

iqc1

100ms

qc1a

qc2a

50ms

qc1

qc2

200ms

cSLS

pSLS

A   B   C   D

Customer 1   ISP/AS1   ISP/AS2   Customer 2
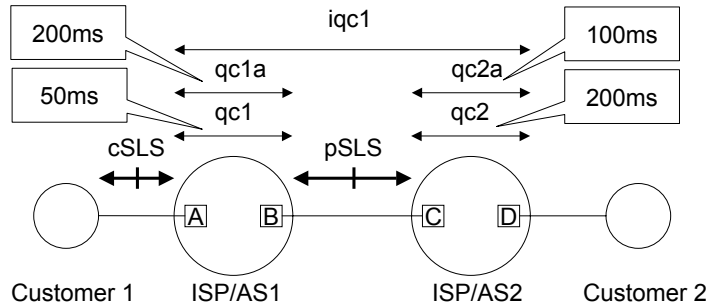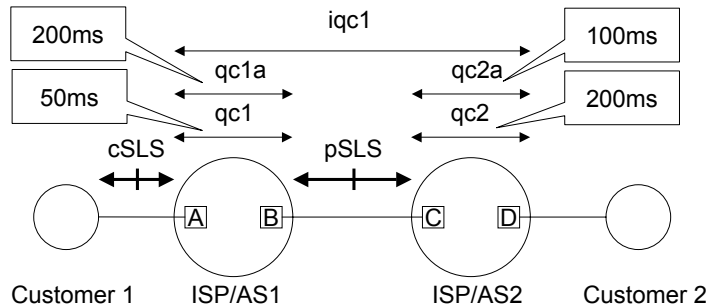
- Considering one way delay only:

- Possible delay values from customer 1 to 2 of:
    qc1 + qc2 = 50 + 200 = 250ms
    qc1 + qc2a = 50 + 100 = 150ms
    qc1a + qc2 = 200 + 200 = 400ms
    qc1a + qc2a = 200 + 100 = 300ms

Example 3: alternative QoS bindings

200ms

iqc1

100ms

qc1a

qc2a

50ms

qc1

qc2

200ms

cSLS

pSLS

A   B   C   D

Customer 1   ISP/AS1   ISP/AS2   Customer 2
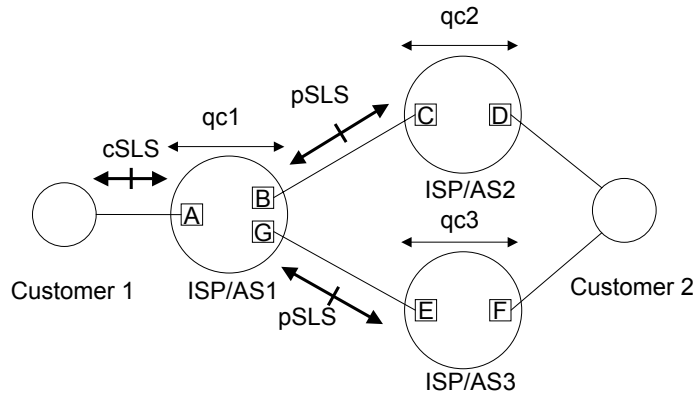
- Considering one way delay only:

- Possible delay values from customer 1 to 2 of:
    qc1 + qc2 = 50 + 200 = 250ms
    qc1 + qc2a = 50 + 100 = 150ms
    qc1a + qc2 = 200 + 200 = 400ms
    qc1a + qc2a = 200 + 100 = 300ms

> QoS bindings of:
> {AS1:qc1, AS2:qc2}
> {AS1:qc1a, AS2:qc2a}
> for iqc1 meet max. delay
> of 300ms
>
> {AS1:qc1, AS2:qc2a} may be
> too expensive...

Example 4: alternative AS paths

MESCAL standardisation objectives

- MESCAL proposes to contribute to standardisation in the following areas
  - SLS Management
    - nsis (next steps in signalling)
  - Traffic Engineering
    - ptomaine (prefix taxonomy ongoing measurement & inter network experiment)
    - idr (inter-domain routing)
    - tewg (internet traffic engineering
  - Policy Management
    - rap (resource allocation protocol)

Please visit:
http://www.mescal.org
for more information