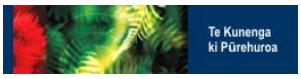
PlaNetLab Options from Massey University

Richard Harris



Presentation Outline

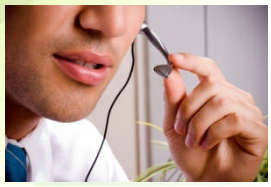
- Service resiliency and reliability
- Quality of Experience
- Modelling requirements
- A PlanetLab proposal

Service Resiliency and Availability

- **Resiliency**
  - Able to withstand failures and faults
- **Availability**
  - Proportion of time that the network is able to accept requests for service

2 December 2008 PDCAT'2008 Dunedin Slide 3

Quality of Experience (QoE)

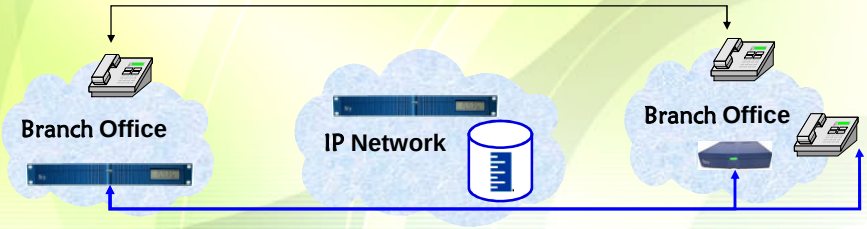


- Surveys of customer expectations suggest that users would expect the same service quality as they received in the former dedicated networks such as the PSTN.
- Achieving network and service reliability simultaneously represents a major challenge for network planners and designers.
- We consider the problem of designing resilient Next Generation Networks to meet specified service quality objectives -- also becoming known as Quality of Experience QoE - with an emphasis on voice (VoIP) and video services.

2 December 2008 PDCAT'2008 Dunedin Slide 4

Introduction to the Concept of QoE - Quality of Experience (e.g. VoIP Network Quality)

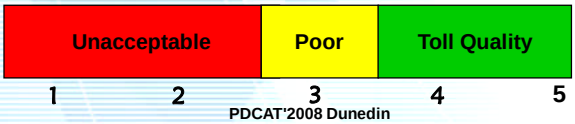
Are we delivering Toll Quality Service?



Late packets, Lost packets, Jitter, Latency

QoE = Subjective valuation of service delivery by end user

Mean Opinion Score (MOS)



2 December 2008 PDCAT'2008 Dunedin Slide 5

The Challenge of Determining the MOS…

- As a result of its subjective nature, the MOS needs to be matched with *objectively measurable quantities* that a service provider can determine since it is not possible to continuously establish MOS scores in real-time.
- In the literature it has been found that many papers dealing with QoE for voice traffic have been based upon the ITU's well-known E-model documented in the G.107 standard.
- This standard incorporates some *20 different measurable parameters* and provides a way of measuring transmission performance for voice traffic.
- Empirical studies with selected user groups, provide a way of matching user MOS scores with the E-model formula, thus creating a link between MOS and objectively measured parameter values used in the E-model.

2 December 2008 PDCAT'2008 Dunedin Slide 6

The Challenge of Determining the MOS – Introduction to the E-Model

E-Model is a transmission planning model that relates transport level metrics to an estimate of customer opinion (MOS)

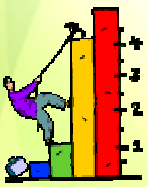
$R = R_o - I_s - I_d - I_e + A$ → User R Factor → Estimated MOS score

- R factor – 0-100 scale
- R_o is the basic factor based on noise levels
- I_s is impairments that occur simultaneously with the voice signal
- I_d is the impairment factor due to delay
- I_e is the impairment due to equipment (codec, etc.)
- A is the advantage factor to allow compensating the score based on application

R	User Satisfaction	MOS
100	Very satisfied	4.5
94.2		4.4
90	Satisfied	4.3
80	Some users dissatisfied	4.0
70	Many users dissatisfied	3.6
60	Nearly all users dissatisfied	3.1
50	Not recommended	2.6
0		1.0

2 December 2008 PDCAT'2008 Dunedin Slide 7

Goal of the Model Definition



- The actual QoE experienced by a user is a function of *network element reliability* and *service reliability*.
- Achieving network and service reliability *simultaneously* represents a major challenge for network planners and designers.
- We consider the problem of designing resilient Next Generation Networks to meet specified Quality of Experience QoE

2 December 2008 PDCAT'2008 Dunedin Slide 8

Applications for the Model

The two main applications for the model are:

1. Network monitoring/management: where we want to know on a minute-by-minute basis an answer to the question: "*How well is the network performing for this service?*" and/or *"Will users be complaining about the service that is being provided?"*
2. Network planning and design: where we want to know *how should the network topology and protocol architecture be laid out and what routing and capacity allocations should be made in order to meet quality of service requirements for loss, delay and all things related to network reliability and service resiliency?*

- There is also a third "application" which is usually part of (2) but can be separated out and made much more detailed from an analytical point of view.

3. Performance analysis: where we want to know answers to questions like: *"If we have the following resources, traffic levels, arrival and service distributions, MTBF statistics and so forth; what performance could be expected to be achieved for services X, Y and Z?"*

2 December 2008 PDCAT'2008 Dunedin Slide 9

Service Resiliency Model Requirements

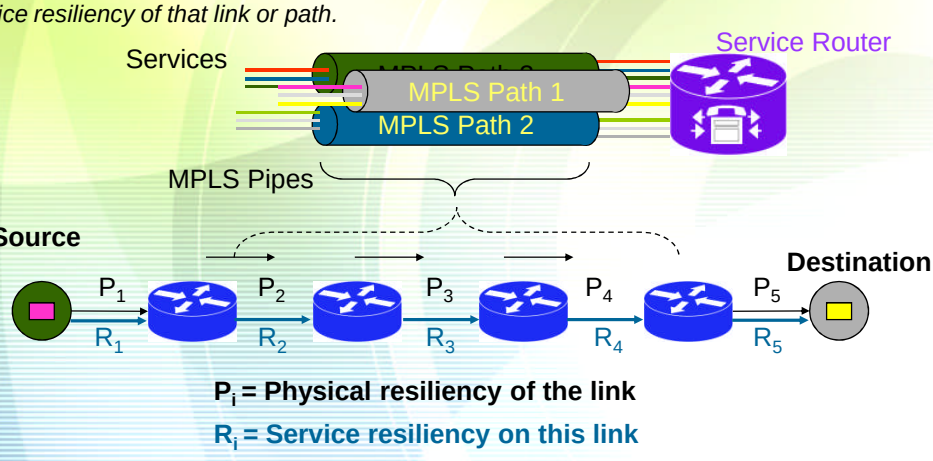
We can briefly summarise these as follows:

- The model must provide a *meaningful measure of service resiliency as assessed by a human subject.*
- Parameters of the model must be *simple to measure*.
- Parameters of the model must be *objectively determined*, but the model *must be appropriately aligned to MOS or similar subjective measures of service quality*.
- It is highly desirable that the measure be a *single value* and represented as either a percentage or numerical value in the range [0, 1].
- It should be possible *to perform simulation studies using appropriately chosen simulation tools* in order to provide estimates of the required parameters and potentially relate them to the Model Definition.
- Similar measures should be possible with *other service types* such as video and audio streaming, gaming, video conferencing and similar multimedia services.

2 December 2008 PDCAT'2008 Dunedin Slide 10

Our Aim - Combined Service Resiliency and Reliability Modelling

We consider the problem of designing resilient Next Generation Networks to meet specified service quality objectives. The ultimate goal is to develop some form of resiliency factor that can be applied to a link or sequence of links in order to establish a "weight" that represents the service resiliency of that link or path.

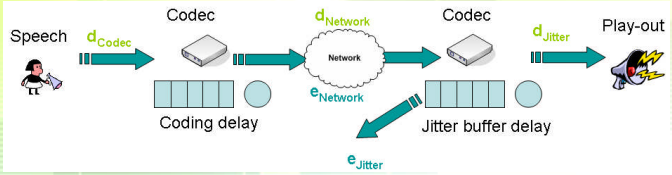


P_i = Physical resiliency of the link

R_i = Service resiliency on this link

A Minimal Set of 5 Parameters

- **An initial model, uses a base set of 3 delay parameters and 2 loss parameters to compute the resiliency measure based upon an adaptation of the E-model for VoIP in paper by Cole and Rosenbluth (AT&T Labs) (which is equation (13) in their paper).**
- **These parameters fit the network service path shown in this figure:**

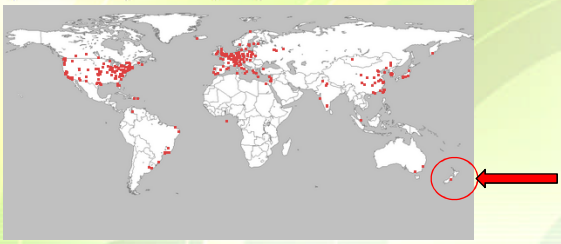


Delay Parameters:
- Codec delay d_{codec}
- Network delay $d_{Network}$
- Jitter buffer delay d_{Jitter}

Loss Parameters:
- Network loss probability $e_{Network}$
- Jitter buffer loss probability e_{Jitter}

Using PlanetLab

PLANETLAB
An open platform for developing, deploying, and accessing planetary-scale services



- **Modelling of VoIP QoE**
  - Determine network delays and losses for simulated VoIP across the PlanetLab network;
  - Use various measures to estimate MOS and relate them to our proposed models for VoIP QoE;
- **Modelling of video QoE**
  - Develop models for video that link MOS to measureable quantities;
  - Determine network delays and losses for video across the PlanetLab network;
  - Use various measures to estimate MOS and relate them to our proposed models for video QoE

2 December 2008 PDCAT'2008 Dunedin Slide 13

Thank you

Te Kunenga ki Pūrehuroa

PLANETLAB
An open platform for developing, deploying, and accessing planetary-scale services