

## Lecture #1

## Objectives and the sense of this endeavour, if any

Let us take as a motto of the course the following thought

- True education is, at heart, a matter of seeing with new eyes what one previously "knew".

So we only need to define what is what in this case.

As a starting point we can take the following opinion expressed by prof. Arto Karila "Umts on järjetön operaatio" [UMTS is a foolish operation, <http://www.helsinginsanomat.fi/uutiset/juttu.asp?id=20000904TA7&pvm=20000904&a=2>]. On the other hand, telecom operators are ready to pay for UMTS licences amazing amount of money. Apparently, it is very hard to make any clear and consistent conclusions about the sense of any essentially new service or technology like UMTS. Still, by a systematic evaluation of the nature of communication services, we can try to remove some of the controversies and confusion about the topic.

One source of confusion is the fact that communication service is not a pure technical issue, and therefore cannot be solved by developing technical specifications. The wholeness of the issue is a convoluted mixture of technical, business and psychological matters, and only a right combination of all aspects can form a success story. Thus we need to understand in addition to the technical basis also business reality and human behaviour – and not only understand, but to take the effect of those issues into account when designing networks and services.

Although we cannot, most probably, give any proof that any specific service or application will be a success or failure, the whole matter is of so great importance that any progress in understanding it is worth of effort.

But how can we keep this ambitious effort in order? Apparently, it is not enough to discuss and assess each separate topic but something is needed to bond the differing aspects. One of the glues used in this effort is the concept of utility (the quality or state of being useful). The necessary expectation for this kind of use of any term is that it is able to evoke appropriate vision related to significantly differing aspects. In this case utility has a reasonable meaning from end-user perspective: any successful application or service must be of some use, or it must contain (on average) a positive utility. From service provider viewpoint the main role of utility is to

describe economical usefulness of a service, or in other words, its capability to produce revenue. From technical viewpoint utility refers to the efficiency of the use of network resources.

Though the versatility of a term is to some extent useful, it brings about a significant risk as well, because different meanings could generate contradicting impressions. In order to avoid severe consequences, we need to somehow define the relationship between the three primary perspectives to utility: customer, operator, and implementation. The view of this document is that "implementation utility" or utilisation is a subordinate compared to the other two perspectives. That is, high utilisation of network resources is a relevant goal per se only if it is possible to prove that high utilisation improves the business opportunity of the operator or customer satisfaction when all relevant aspects are taken into account. And that is usually very hard, or even impossible, to show.

The relationship between operator and customer perspectives is less clear. However, the primary assumption of this endeavour is that in most cases there is a quite strong positive correlation between the capability of a service to create customer satisfaction and business opportunity for the service provider. We may assume that the customer satisfaction and the cost of service provision are the two primary factors that determines the probability of business success, particularly if one service provider could offer the whole service in isolation. In practice the situation is more complicated because of competitors and required partners. The emphasis of this endeavour is on the customer side whereas complicated business issues are mostly ignored.

Thus one session is used to shed light on the utility from user perspective. The main topics discussed in the session are the utility functions of different applications, fairness issues, and service models including charging. Roughly speaking the utility of an application is theoretical factor that defines how useful an application is for an average user when the application is used without thinking other users and without any real customer relation to a service provider. In addition the concept fairness can be used to take into account the fact that an ordinary user quite often compares his situation with others, and even if the real service could be satisfactory as such, the user can be dissatisfied if he believes that other get better service. Therefore, fairness seems to be an issue that cannot be incorporated into ordinary utility calculations.

Finally the effect of price on customer satisfaction is an issue that we have to assess separately. In a simplistic model, we just need to define the price that an average user is likely ready to pay. However, this cannot be a general model because the

actual connection between price and service demand is more complex. There are various pricing structures, various user categories, various ways to implement network services etc. Once again, for a realistic evaluation we need to identify the most relevant issues, and model the characteristics of each issue in a feasible, but simple way.

Then the other side of the economics is the cost of service provision. The objective is to somehow cover issues from one link to a large network domain and from the delivery of one packet to the medium-term relationship between a customer and a service provider. The third essential dimension is the level of aggregation: many things are easy to do with one separate packet but not reasonable on other, higher level of aggregations, and vice versa. At least individual packets (maybe even smaller entities of information), packet flows and larger aggregation of flows have to be included in the evaluation. So the two outer corners of the endeavour are one packet on one link, and the handling of large aggregates within a large network domain during one month. Both utility and cost calculations have to cover this wide region. Note that what can be easily done for one packet on one link could be practically impossible to do for all the packets handled in the network domain in a month (for instance, any approach that requires to maintain any per packet information is questionable since the total number of packet handling events per month could easily be  $10^{12}$  in a large network).

Anyway, the ultimate target of the handling of an individual packet and large aggregates is the same: to create improved customer satisfaction and by that means to generate revenues for the service provider.

Service is another key issue to be defined. Without thorough understanding of the service model, there is no hope to link technical issues to customer utility, because end-to-end network service *is* the link that connects technical mechanisms and customer utility. Basically there are two primary service approach: the first one concentrates on the building of basic transfer capability, while the other one tries to realise advanced transfer service. Although we are inclined to think that the other one is better service, and therefore shall be the ultimate target of any serious service provider, we shall not take that assumption for granted. Since the roots of the current Internet service are deeply in the first approach, there must be some clear advantages in an approach that just offers necessary tools to transmit packets, and do not try to offer any advanced transmission service.

These are the main questions that will be discussed in the lecture series. But discussing is only a part of the whole issue; the other part is implementing something. We may conclude that certain model would be the most promising one,

but then notice that the current available specifications and technology do not fit to the model. The last sessions will try to be realistic in a way that they provide some guidelines how to implement the most reasonable models by the current technologies, like IntServ, RSVP, MPLS and DiffServ.