RTT TECHNOLOGY TOPIC
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# Reality Gaps

Over the past 15 years we have observed (and over the past ten years measured) three stages of **technology maturation** in cellular wireless networks, each stage lasting five years.

Our colleagues in The Shosteck Group observed and measured almost identical **market maturation** time scales. This led us to produce a premise of a technology and business **maturation cycle** that could be used to forecast which technologies would 'succeed', which would 'fail'.

The technology and market maturation cycle goes as follows:-

| **Immaturity** | **Maturity** | **Overmaturity** |
|---|---|---|
| PAIN | PLEASURE | PERFECTION |
| First Five Years | Second Five Years | Final Five Years |

(The Shosteck Group add in an earlier stage of 'Euphoria' but ours is the simplified version).

In the first 5-year period (PAIN), neither handsets nor networks work well. Additionally, costs of handsets are high and end-user value is low. Why should end-users change out handsets when their old ones work perfectly well.

In the next 5 years (PLEASURE), handsets easily exceed their conformance specification and the networks behave more or less as original simulations suggested. Economies of scale are realised. End-user value becomes clear.

In the final 5 years (PERFECTION), the handsets and network have been developed to a point where it is technically or commercially difficult to deliver additional performance improvement. In some cases, if the air interface or network interfaces are asked to do something they were not designed to do, performance degrades. Additionally, engineers get bored and prefer to move on to new projects.

For example, in 1990, no GSM phones existed that could possibly meet the sensitivity specification (-102 dBm). By market launch in 1992, some phones met specification, some did not. Over the next three years, sensitivity improved by typically 1 dB per year. Partly this was due to device and design improvements, partly this was due to the performance gains realised from market volume - closer device and design tolerances on the production line.

Given that every dB of sensitivity improvement translated into an effective 10%

improvement in coverage, **handset performance gain** translated into better, **more consistent network performance**.

Note however that it was not until 1995 that the benefits of GSM over TACS (talk time, standby, size, voice quality) become generally persuasive.

From 1995 onwards (the pleasure period), performance gains continued and costs continued to reduce. However, towards the end of the 1990's, dual band and tri-band phones combined with smaller form factors tended to decrease rather than increase sensitivity and made it harder to maintain year on year cost reductions.

From 2000 onwards (Perfection), the introduction of GPRS has proved problematical not only in terms of additional power drain but also because of the impact of TX multi-slotting on receive sensitivity. The handset is being asked to do something it was never designed to do.

Similarly with the network topology, GSM was designed as a circuit switched architecture. Efforts to impose a packet routed topology on a backhaul network optimised for carrying 16 kbit voice circuits have not, to date, been a success.

We can expect the same pattern with IMT2000DS deployment. (IMT2000DS as defined in 3GPP for UMTS W-CDMA.) Early iteration handsets will fail to meet specification in terms of sensitivity and will have a poor (barely acceptable) power budget. The failure to meet sensitivity targets will mean that the networks will not perform well (or as expected) until at least five years from market introduction. This is **not** a reason not to introduce the technology.

Handset sensitivity will improve as DSP performance improves. In parallel, techniques like multi-user detection promise significant improvements in uplink sensitivity.

After the 'Pain' period, the technology achieves maturity and begins to deliver competitive market advantage (technology driven profit opportunity).

There are presently persuasive arguments being put forward that the CDMA2000 1x networks deployed in Korea and soon in the US have already reached technology maturity (due to their similarity to IS95 CDMA) and are therefore by implication five years ahead of IMT2000DS in terms of deployment timescale.

It is certainly true that, in comparison, there is presently no wide scale implementation experience with IMT2000DS.

Proponents of IMT2000DS would argue that the backward compatibility benefits of IMT2000DS (GSM/IMT2000DS radio and network bandwidth integration) will outweigh this timescale disadvantage.

## REALITY GAPS

In turn, this highlights an additional feature of technology and market maturation - the 'reality gap'.

The 'reality gap' is the gap between what a technology actually delivers and what the customer (in this case, the network operator and end user) expects.

Technology expectations do not stand still but move forward over time. For example, improvements in wireline performance (ADSL, HDSL, VDSL) increase bandwidth and **bandwidth quality expectations**. ADSL, apart from delivering a higher bit rate, also delivers a 1 in $10_{10}$ bit error rate - substantially better than existing wireless networks.

Reality gaps tend to be largest in the pre-launch pre-pain phase (the Shosteck 'Euphoria' zone) and then slowly decrease through the first five years (Pain).

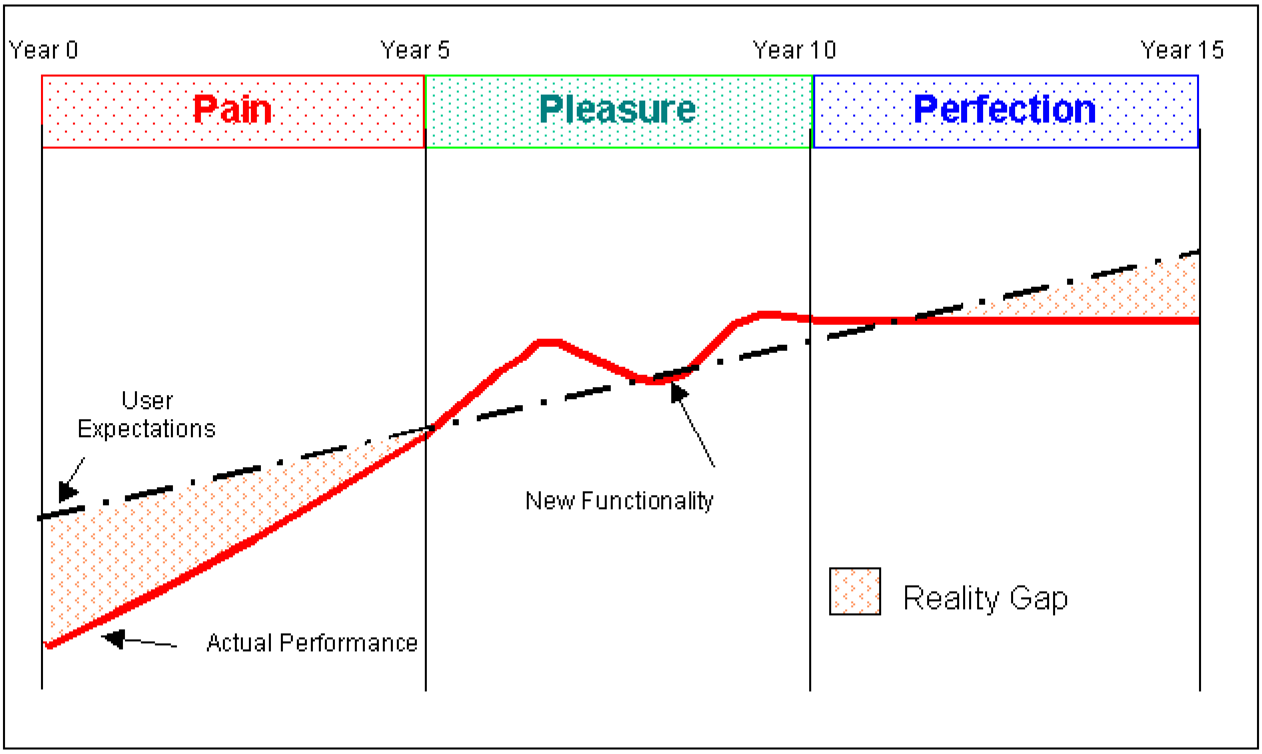


**Figure 1 - Reality Gap - 'Successful' Technology**

In a 'successful' technology, performance begins to exceed customer expectations (the pleasure zone) - the reality gap disappears. As expectations continue to increase through the perfection phase, the reality gap re-appears.

For some technologies, the gap **never** closes.

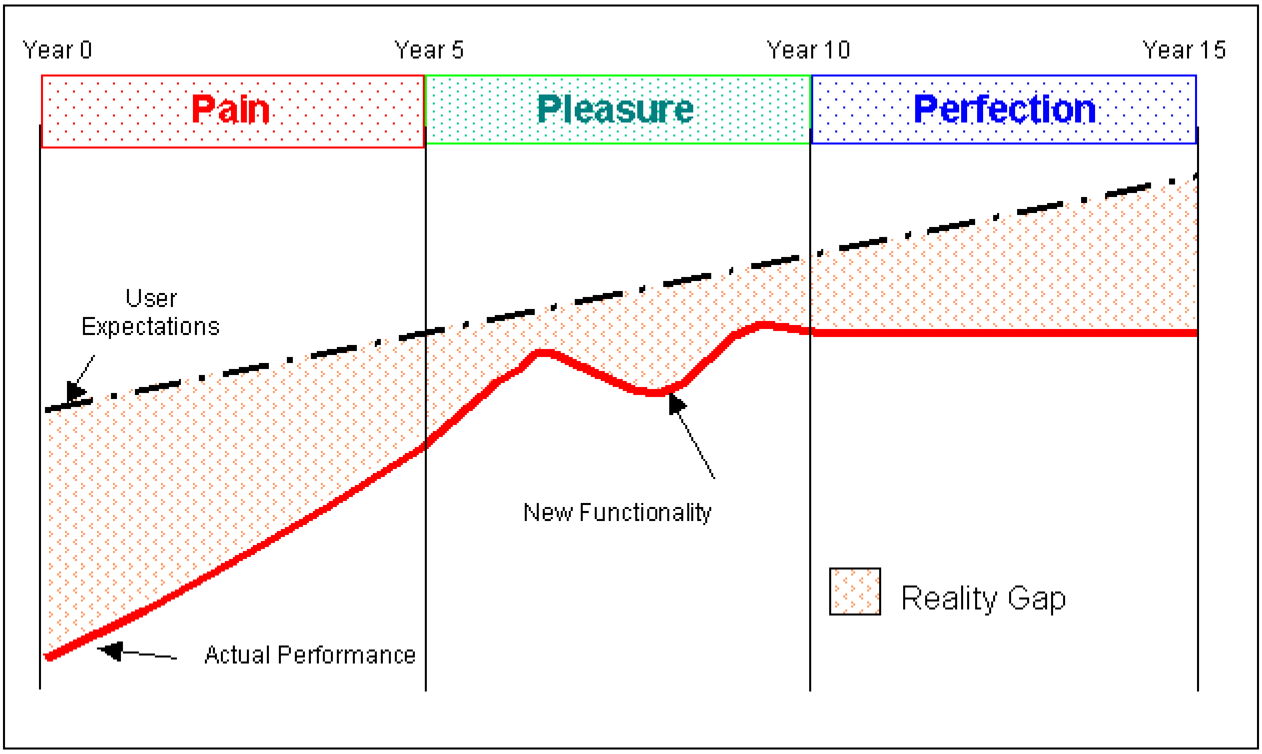


**Figure 2 - Reality Gap - 'Failed' Technology**

Customer expectations move faster than the technology. This may be due to fundamental technology limitations and/or resource limitations (not enough good people solving the problems).

These technologies we define as 'failed technologies'.

This may seem like an over-simplistic methodology but it has proved remarkably robust as a mechanism for identifying which technologies will 'fail' and which will 'succeed'. It allowed us to forecast the failure of first generation wireless fixed access, first generation digital cordless (CT2 and early DECT deployment), Iridium, WAP and (more recently) GPRS, EDGE and Bluetooth.

## About RTT Technology Topics

RTT Technology Topics reflect areas of research that we are presently working on.

We aim to introduce new terminology and new ideas to clarify present and future technology and business issues.

Do pass these Technology Topics on to your colleagues, encourage them to join our Push List and respond with comments.

## Contact RTT

RTT, the Shosteck Group and The Mobile World are presently working on a number of research and forecasting projects in the cellular, two way radio, satellite and broadcasting industry.

If you would like more information on this work then please contact

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