RTT TECHNOLOGY TOPIC
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Autonomous Devices
Theoretically useful, practically limited

This month's technology topic discusses the arguments for and against giving client devices the ability to make autonomous decisions.

To an extent this already happens. A smart phone turns off the screen and or changes processor clock speed and or voltage but other decisions such as physical layer access control are done at the base station or further in to the network core.

As networks get bigger and denser it is theoretically advantageous to distribute decision making to the network edge. Decisions are made faster and signaling traffic is reduced. However device based decision making requires devices that behave predictably and consistently across a broad range of operating conditions and access to information that may not always be available.

This is an issue presently being debated within the mobile broadband standards community and we have drawn on a new book from John Wiley 'An Introduction to LTE' written by Christopher Cox to show how decision making functionality is distributed within present networks and to discuss likely future trends.

The book which is very thorough and readable can be ordered from Amazon via the **RTT book shop.**

The topic is also addressed in RTT's latest book '**Making Telecoms Work- from technical innovation to commercial success'** published In January 2012. Also available from the **RTT book shop.**

Distributed decision making in LTE

Traditionally in cellular networks, a device will be given a neighbour list from the serving base station listing the candidate base stations which the mobile is required to measure and report to the network.

As networks become denser this introduces additional signalling load and flattens the battery in the mobile.

Release 9 LTE manages this in idle mode (RRC Idle) by allowing the mobile to find LTE cells by itself, creating its own neighbour list and measuring the other target handover candidates at a rate of one carrier frequency per minute. The mobile decides whether to stay on the initial serving base station or move to a new one.

The decision is partly determined by how fast the mobile is moving and the rate at which the neighbour list changes, registered as a normal, medium or high mobility state. The mobile only talks to the network if it moves into a new tracking area. The caveat here is that in FDD networks the mobile can only measure the downlink and the link may be uplink limited (and often will be in LTE) in which case only the base station will have visibility to both ends of the link.

In 'RRC connected' mode the network takes control but minimises signalling load and power drain by adjusting the measurement reporting interval to be anything between 120 milliseconds and 60 minutes and or by using an event trigger based algorithm based on signal strength and quality thresholds.

However the tricky bit here is how to implement inter band and inter system handovers, for example handovers to and from GSM and GSM and CDMA 2000 in the US while also managing inter band channel aggregation. This will either need dual receiver paths in the mobile or measurement sub frames

where the base station promises not to transmit. Either way it is hard to imagine that this will not create more signalling activity and an argument could be made that the mobile should be allowed to run its own best connect algorithms in order to make the process more efficient both in terms of power and bandwidth consumption.

But the benefits of this are hard to quantify. Effectively this is an extension of the problem that smart phones have today given a choice of cellular or Wi Fi access. It is sensible for a smart phone to log on to a home Wi Fi network but it can only do that if Wi Fi scanning is enabled which means power is being consumed looking for beacon channels that most of the time will not be suitable. The alternative is to use other decision information, for example GPS, to determine best connect options or at least prompt the user to log on to the home Wi Fi network.

The discussion therefore revolves around whether a mobile should be capable of self-configuration and self-optimisation at the physical layer. For example base stations are becoming self-configurable at least from Release 8 onwards in order to realise the concept of self-optimising or self-organizing networks.

These base stations have to be deployed with LTE home cells that have no pre knowledge of their neighbours. The self-configuration is based on a short list of allowed physical identities downloaded from the network. The base station then rejects any identities that mobiles list in their measurement reports and any that nearby base stations list.

There is then an automatic neighbour relations procedure where the base stations exchange information about all the cells they are controlling including their global cell identities, physical cell identities and carrier frequencies. The network has not been involved in the process other than sending out the initial configuration parameters.

There are of course other networks which can operate in direct mode where mobiles talk to each other without a base station, **D**irect **M**ode **O**peration TETRA being one example where the local configuration is established with one mobile as the master managing a group of slaves. The master can also act as a relay or repeater to connect the sub group with a base station.

There are work items in LTE Advanced studying the applicability of these techniques to mobile broadband cellular networks. Theoretically it is a neat way of extending coverage but the idea of your mobile being used to relay the traffic from other mobiles is probably impractical – sharing battery bandwidth with your neighbours implies an unlikely level of altruism.

Similarly the concept of user devices that self-configure and self-optimise at the physical layer while attractive is likely to be defeated by practical considerations. Crucially the inability of user devices to have visibility to the overall operating environment limits their ability to make informed decisions.

For the foreseeable future the cellular base station remains as the local boss with the network still firmly in overall control.

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 help inform present and future technology, engineering, market and business decisions although as you can tell we sometimes stray into more philosophic territory. There are over 130 technology topics **archived on the RTT web site.** Do pass these Technology Topics and related links on to your colleagues, encourage them to join our **Subscriber List** and respond with comments.

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RTT, the Jane Zweig Group and **The Mobile World** are presently working on a number of research and forecasting projects in the mobile broadband, two way radio, satellite and broadcasting industry. If you would like more information on this work then please contact
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