Out-of-Service Performance

Introduction

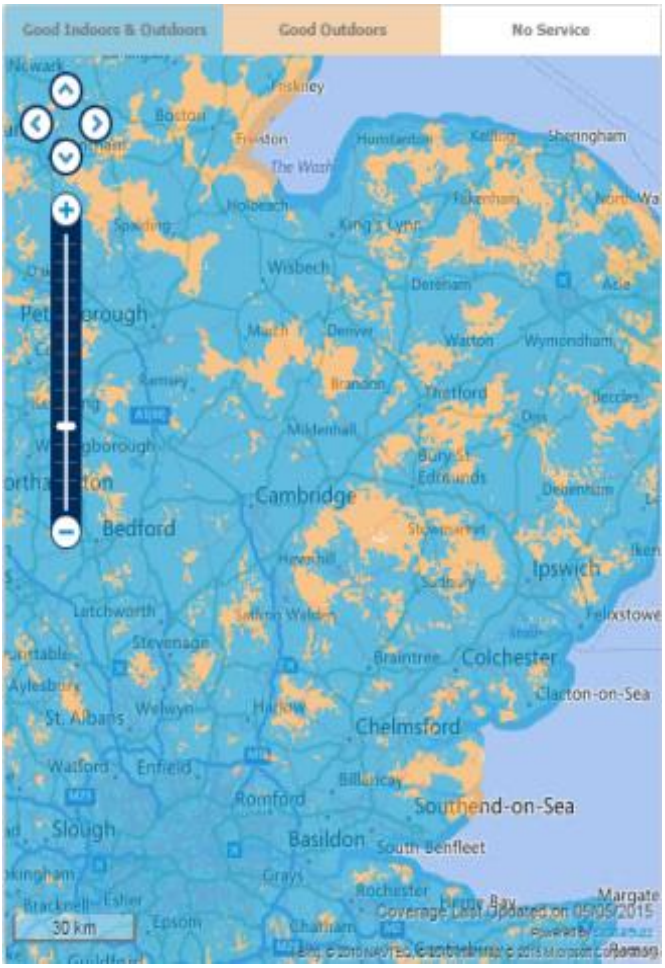
As mobile networks evolve, they face increasing pressure to ensure the coverage of their latest network technology is the same as the previous generations. With GSM being the first mainstream digital cellular technology deployed, it is no surprise that GSM coverage has grown immensely over its many years of use. UMTS has somewhat less coverage than GSM and the most recent technology to be deployed, LTE, has even less than UMTS. All this leads to geographic areas with weak or no coverage.

End User Experience

Such areas can leave a user in an ***Out of Service*** state. This can be either *Limited Service,* where the device camps onto a cell from another network and allows emergency calls only, or worse, an *Out of Coverage* state which leaves the user unable to access any service, even to make an emergency call.

There is a trade-off for a cellular radio device between regaining service promptly and minimising power consumption while in an ***Out of Service*** state.

IOTAS can provide a method to validate your device against a range of reference devices to see how your own device performs.



Standards

The behavior of a cellular radio device in ***Out of Service*** state is largely a proprietary consideration by the manufacturer.

If no cell can be selected then 3GPP TS 24.008 sub-clause 4.1.2.1.2 states the following;

- *This state is entered after a first intensive search failed (state 19.7). Cells are searched at a low rhythm.*

The periodicity of searches, and the searched bands and RATs are therefore matters of **optimisation** by the manufacturer.

Proposed Testing

As the way a device behaves in an ***Out of Service*** state is largely based on proprietary optimisation, it is essential that all testing is conducted in parallel with reference / competitor devices.

IOTAS will investigate;

- Transitions to ***Out of Service*** state
- Cell searches and RATs / bands searched
- Transitions to ***Out of Service*** state to Limited Service state (if applicable)
- Transitions to ***In Service*** state
- Cell reselections in limited service

IOTAS have developed an in house solution based around a commercially available automated field test and measurement platform.

Key Performance Indicators

The Out of Service key performance indicators (KPIs) are broadly as follows:

- *The number of cell searches performed while Out of Service*
- *The duration for which a device was Out of Service*
- *The RAT of the cell service was regained on (depending on availability)*
- *The time taken to obtain service on the highest priority RAT i.e. LTE*



The Solution

IOTAS test 3 different Out of Service scenarios* covering durations of 30, 60 and 90 minutes

- LTE Service -> Out of Service -> LTE Service

  Performed in an urban area using a subterranean multi-storey car park

  Upon returning to area of LTE service, devices may enter Limited Service state and obtain service in GSM and / or UMTS before regaining LTE service

- UMTS Service -> Out of Service -> UMTS Service

  Performed in a rural area that can be accessed from an area of UMTS service without traversing an area of GSM service

  Upon returning to an area of UMTS service, devices may enter Limited Service state and obtain service in GSM before regaining UMTS service

- GSM Service -> Out of Service -> GSM Service

  Performed in a rural area with no service adjacent to an area of GSM service

  Upon returning to an area of GSM service, devices may enter Limited Service state before regaining GSM service

**Other scenarios can be added if required.*

Metrics

For each transition into and out of an area of no service, the logged data is post-processed to obtain the following data sets:

- Overall time spent in Out of Service state
  - *Starting at the time at which the MM/EMM NAS layers of a device indicate that no service is available*
  - *Ending at the time at which the MM/EMM NAS layers of a device indicate that Normal Service has been restored or if it has obtained Limited Service*
- Cell searches while in Out of Service state
  - *Times at which cell searches are initiated by a device*
  - *RATs and bands scanned by a device during each cell search*
- Service restoration after leaving Out of Service state
  - *Time at which a device enters Limited Service state and RAT of cell (if applicable)*
  - *Time at which a device regains service on the previous serving RAT prior to entering Out of Service state*
  - *Time(s) at which a device regains service on intermediary RAT(s) (if applicable)*

Test Reporting

A summary for each combination of scenario and Out of Service duration tested shall include the following:

- Out of Service Statistics Table
- Service State Histograms for each transition into and out of an Out of Service area
- Cell search histograms for each period spent in an Out of Service area
- Summary of observations

Tables accompanying each summary of the post-processed log extracts used to generate statistics tables and histograms

An overall assessment of a device's Out of Service performance upon completion of all testing

