Network Redundancy

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Agenda

• A GSM-R Network - Sub-systems making up the network
• Reliability and Availability
• Nodal redundancy
• Sub-system redundancy
• Site / Geo-redundancy
• Configurations and Features
• Conclusions
A GSM-R Network

Sub-systems making up the network
Reliability and Availability

Expressing redundancy in figures

- GSM-R stands for a mission-critical network
- Availability requirements are beyond typical Public Operator networks

- **System reliability**
  - Based on statistical data for a sub-system
  - Function of Failure rate and time
  - Typical occurrence of a failure on a certain blade is every 300k to 500k hours
  - The availability of the Sub-system is 99,999994%

- **Service Availability**
  - Presented for call scenarios like MS REC to FDN
  - Function of MTBF, MTTR and configuration
  - Availability example of MS REC to FDN call is 99,99982103%
  - This means an annual downtime of 0,9407 minutes.
Reliability and Availability cont’d

Availability – a function of MTBF, MTTR and configuration

- Configuration means Redundancy

\[
A_{sys} = A_1 \times A_2 \times \ldots \times A_n = \prod_{i=1}^{n} A_i
\]

\[
R_{sys} = R_1 \times R_2 \times \ldots \times R_n = \prod_{i=1}^{n} R_i
\]

Parallel system Availability:

\[
A_{sys} = 1 - \prod_{i=1}^{n} (1 - A_i)
\]

Parallel system Reliability:

\[
R_{sys} = 1 - \prod_{i=1}^{n} (1 - R_i)
\]

N Parallel system availability with identical \(A_i\):

\[
A_{sys} = 1 - (1 - A_i)^n
\]

N Parallel system reliability with identical \(R_i\):

\[
R_{sys} = 1 - (1 - R_i)^n
\]
Nodal redundancy

The basic redundancy of a Sub-system already contributing to Availability
Nodal redundancy

The basic redundancy of a Sub-system already contributing to Availability

Some measures

- 2 redundant power modules
- 2 redundant cooling units
- 2 redundant shelf / alarm managers
- Redundant interfaces / connectors inside and outside
- 2 or more redundant blades in active/active or active/standby
- Components are hot swapable during operation
Nodal redundancy

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A major difference to Public Operator deployments is on the access

- An outage of a BTS in a public network does not hurt too much
- In GSM-R deployments it does
- Opposite to public BTS’s, access components in GSM-R are fully redundant
Sub-system redundancy

Making a redundant system even more redundant
Sub-system redundancy

Making a redundant system even more redundant
Sub-system redundancy

Making a redundant system even more redundant

- **Release 4 MSC-S**: Active/Active or Active/Standby
- **Release 4 HLR**: Mated Pair Active/Active
- **Release 4 MGW**: Loadsharing Active/Active
- **STP/SGW**: Loadsharing Active/Active
- **SCP**: Mated Pair Active/Hot-Standby
- **SGSN/GGSN**: Loadsharing Active/Active
- **OAM**: Active/Hot-Standby

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Site / Geo-redundancy

Any redundancy measure does not help in case of a disaster

- A disaster is defined as a sudden catastrophic event such as:
  - Fire, flood, lightning storm
  - Tornado, Earthquake, Hurricane
  - Explosion, Terrorism
  - any other incident causing damage beyond normal repair to telecommunications facilities
- The result is that extensive hardware replacement may be required and a potentially extended outage situation exists.
- Except...
Site / Geo-redundancy

Having two Sub-systems allows to split the sites and being safe against disasters
Configurations and Features

A specific configuration for railways exists

- Each BTS in O1+1 configuration, i.e. 1 active TRX and one stand-by
Configurations and Features

A specific configuration for railways exists: **double layering radio coverage**

- Two BTS’s covering the same track – an entire outage will have no impact
- Each BTS is connected to a different BSC
- Each BTS in O1+1 configuration, i.e. 1 active TRX and one stand-by
An example for interaction of access and core: **RAN Flex with GCR Redundancy**

- RAN Flex provides the ability for BSCs to connect to more than one MSC-S in a pool area
  - MSC Servers are grouped into a pool
  - Traffic is load shared across the MSC-S pool resources
  - A terminal may roam within a BSS area without need to change the serving MSC node

- In case of MSC-S failure, all of the BSCs can access instantaneously the other MSC-S in the pool and Group Calls are possible through the support of GCR redundancy.

- The feature is conform to ETSI TS 103.147
An example for improved access redundancy: **Secured Loop**

- The secured BTS loop feature prevents from any service interruption in case of a single PCM (or PCM interface board on BSC) failure in a BTS loop.
- In case of a PCM failure in BTS loop
  - Calls are maintained
  - Signaling links are maintained and automatically switched over to the redundant path
Conclusions

• **GSM-R**
  – stands for a mission-critical communication network for Railways
  – is focussed on voice communication and signalling data transportation
  – has higher demands on availability than Public Operators – beyond the 5 9’s

• **Redundancy is a function of Reliability and Availability**
  – Availability is calculated for a Sub-system
  – Service availability is aggregated for a service the network provides, e.g. a call
  – Redundancy enables highest service availability figures as demanded by railways

• **For GSM-R we are dedicating major investments to continuously**
  – improve the availability of the Sub-systems, meaning our products
  – derive new configurations options and implement features increasing the service availability of the GSM-R network
Join us at the UIC Afterworks Party!
For all railway organization and Kapsch partners:
11 Sept, 16:00 - 22:00h
La Barge,
Port de Javel Haut
Thank you!