Network Redundancy

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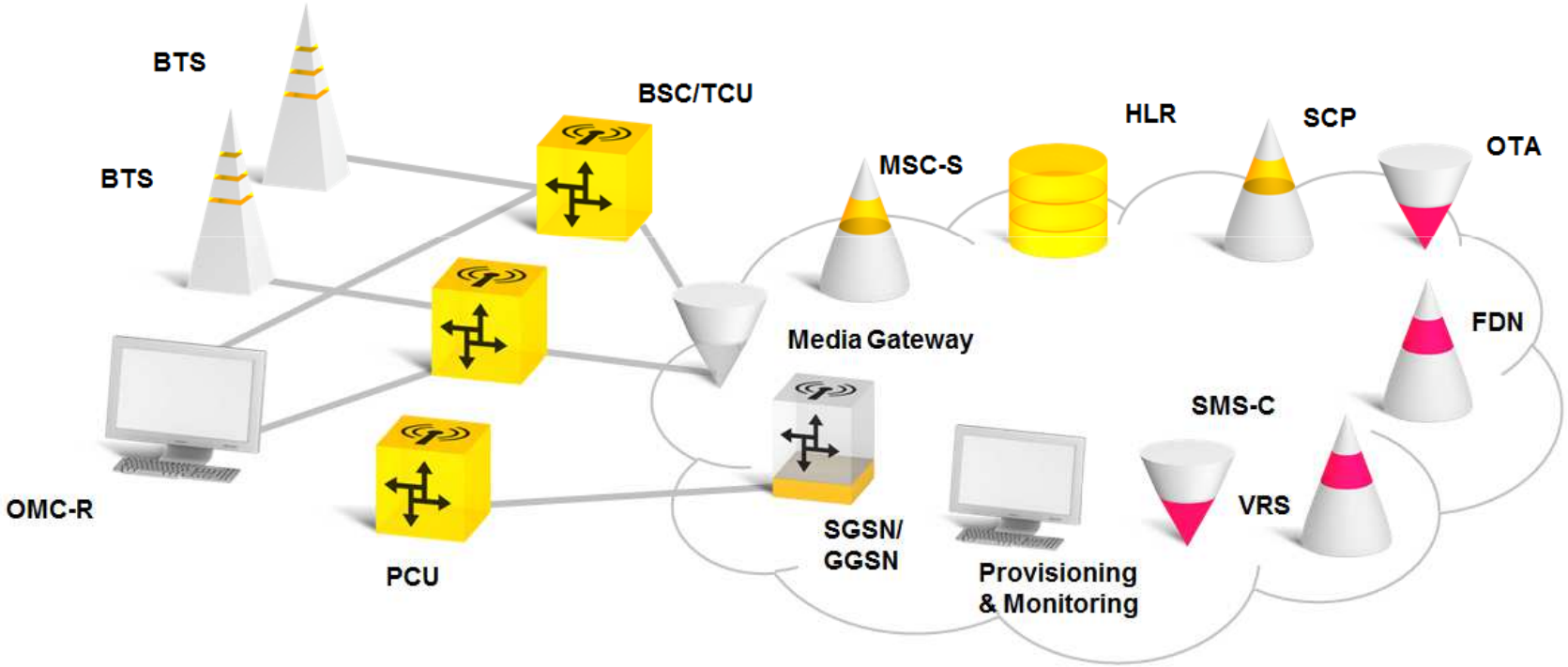
Agenda

- 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

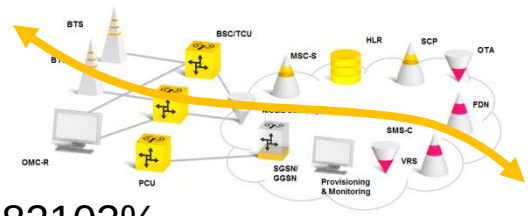


Reliability and Availability

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

Serial system Availability: $A_{sys} = A_1 * A_2 \dots A_n = \prod_{i=1}^{n} A_i$

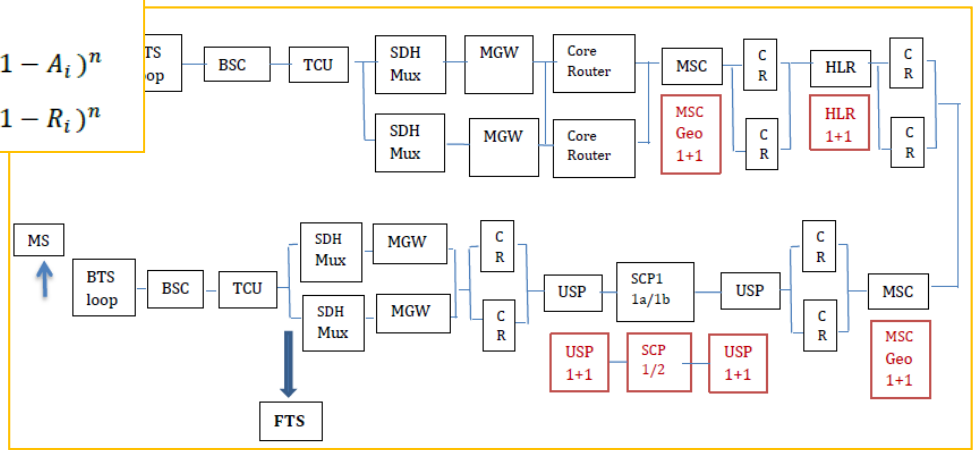
Serial system Reliability: $R_{sys} = R_1 * R_2 \dots R_n = \prod_{i=1}^{n} R_i$

Parallel system Availability: $A_{sys} = 1 - \prod_{i=1}^{n}(1 - A_i)$

Parallel system Reliability: $R_{sys} = 1 - \prod_{i=1}^{n}(1 - R_i)$

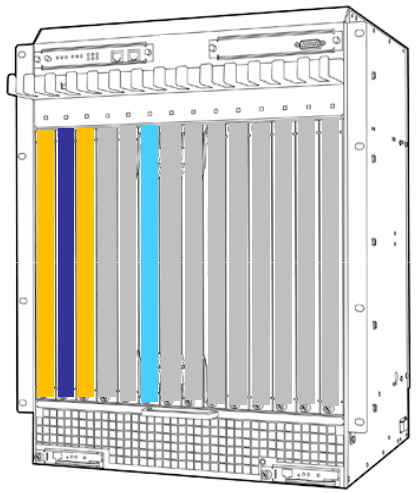
N Parallel system availability with identical A_i: $A_{sys} = 1 - (1 - A_i)^n$

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

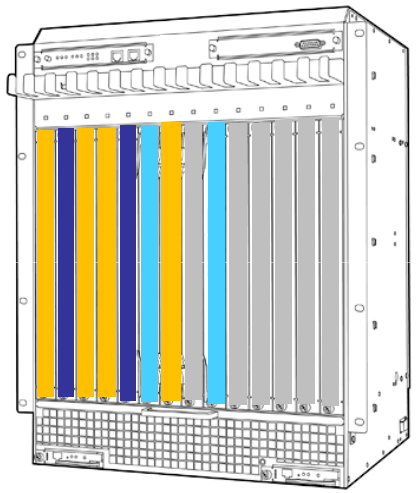


Nodal redundancy

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



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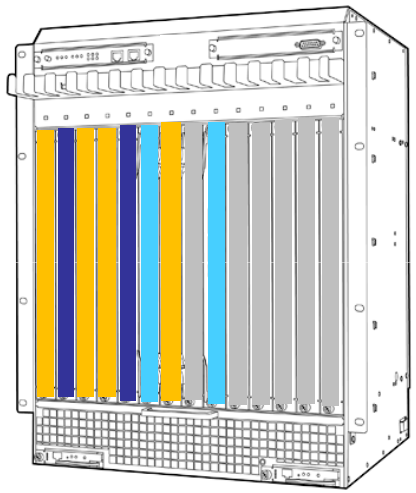
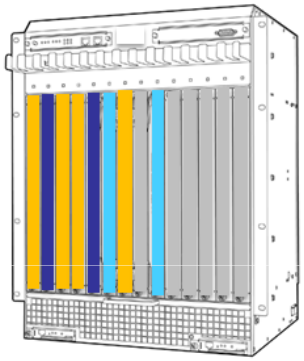


A major difference to Public Operator deployments is on the access

- 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

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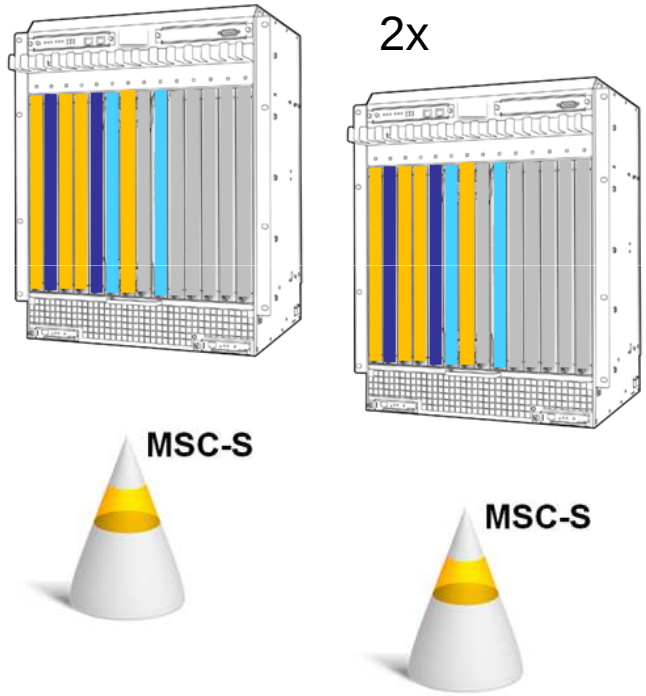
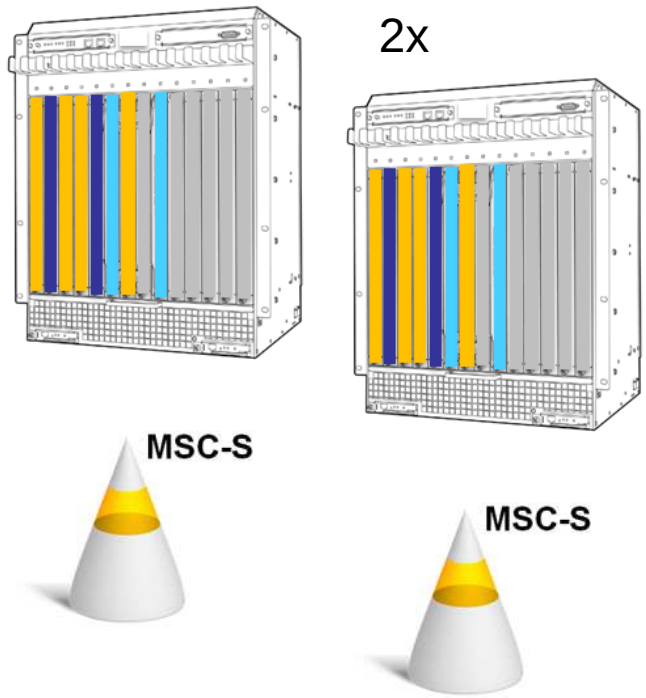


Sub-system redundancy

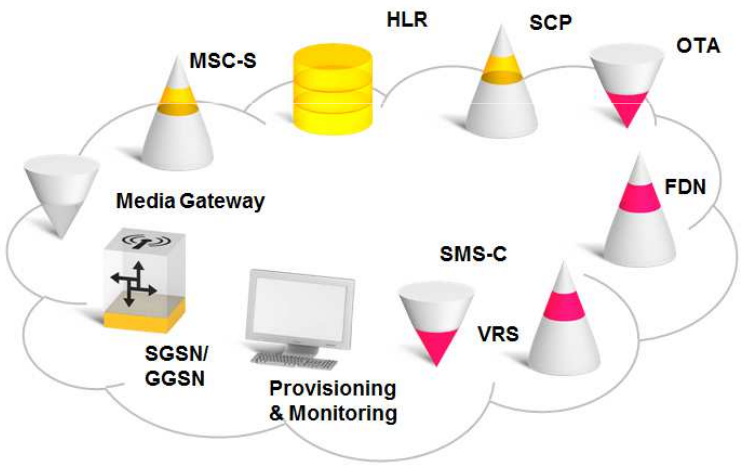
Making a redundant system even more redundant

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**



Site / Geo-redundancy

Any redundancy measure does not help in case of a disaster

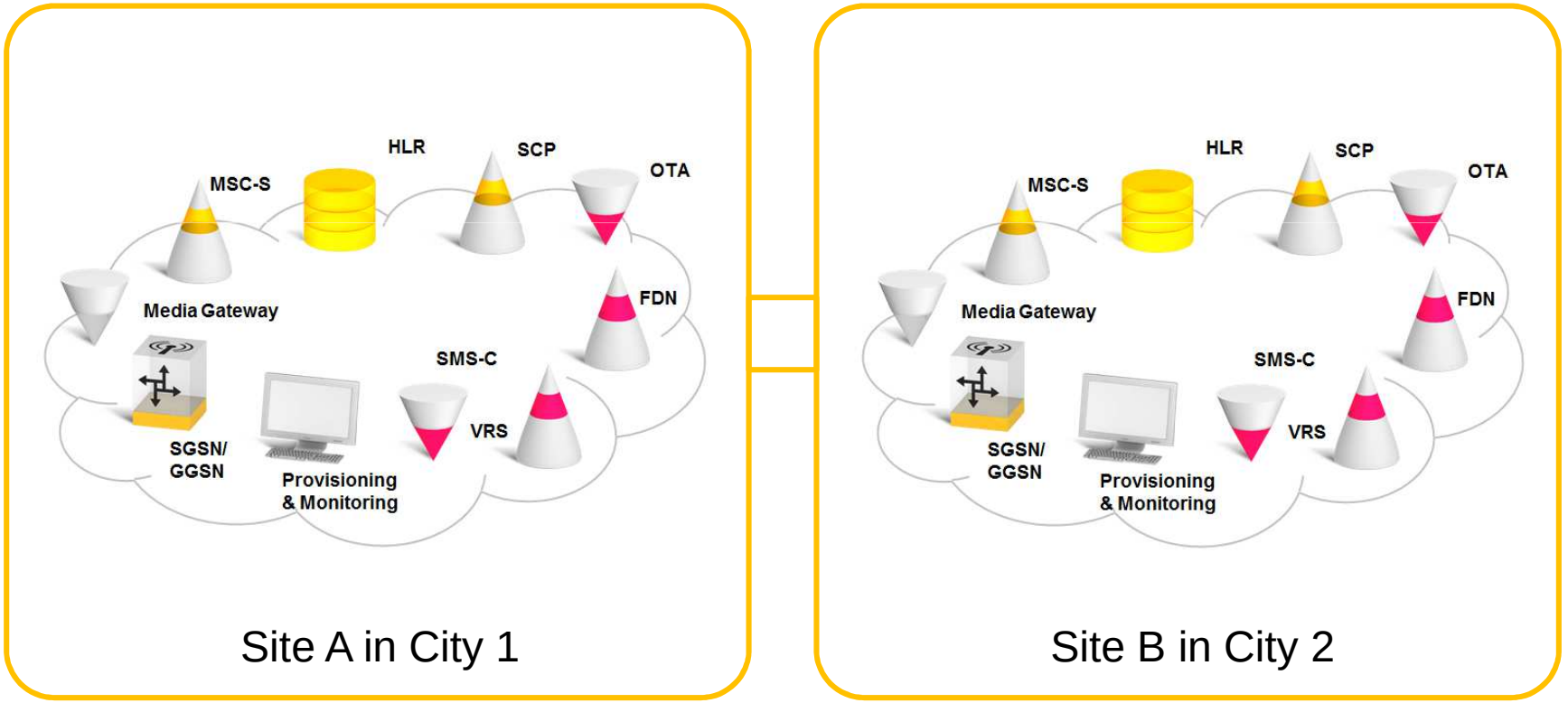


GSM-R Site

- 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 my be required and a potentially extended outage situation exists.
- **Except...**

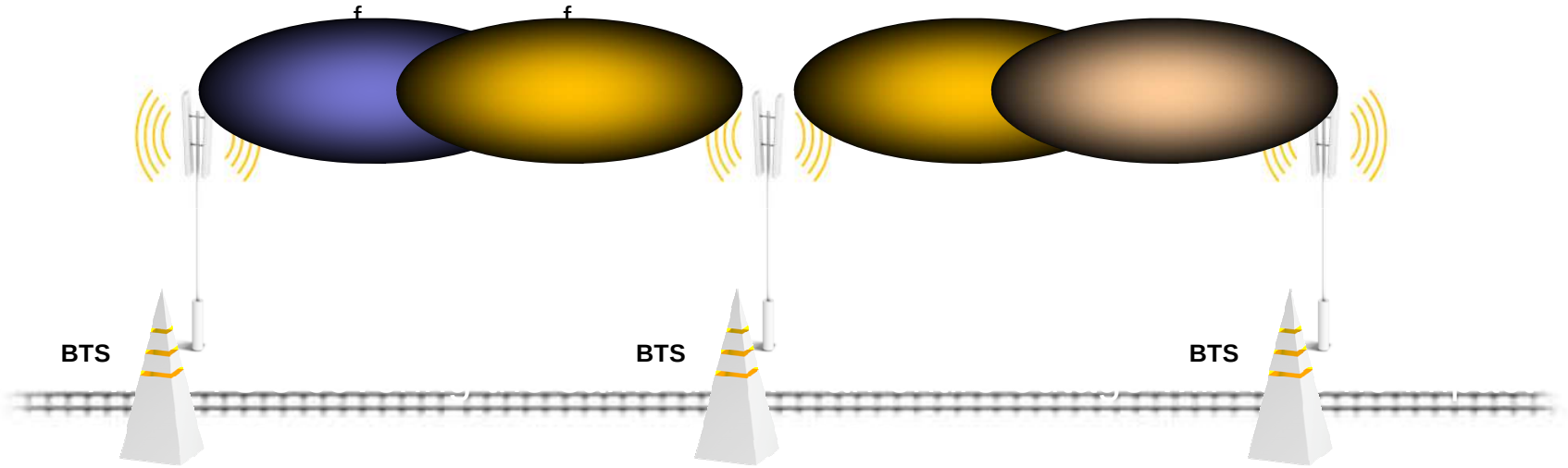
Site / Geo-redundancy

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



Configurations and Features

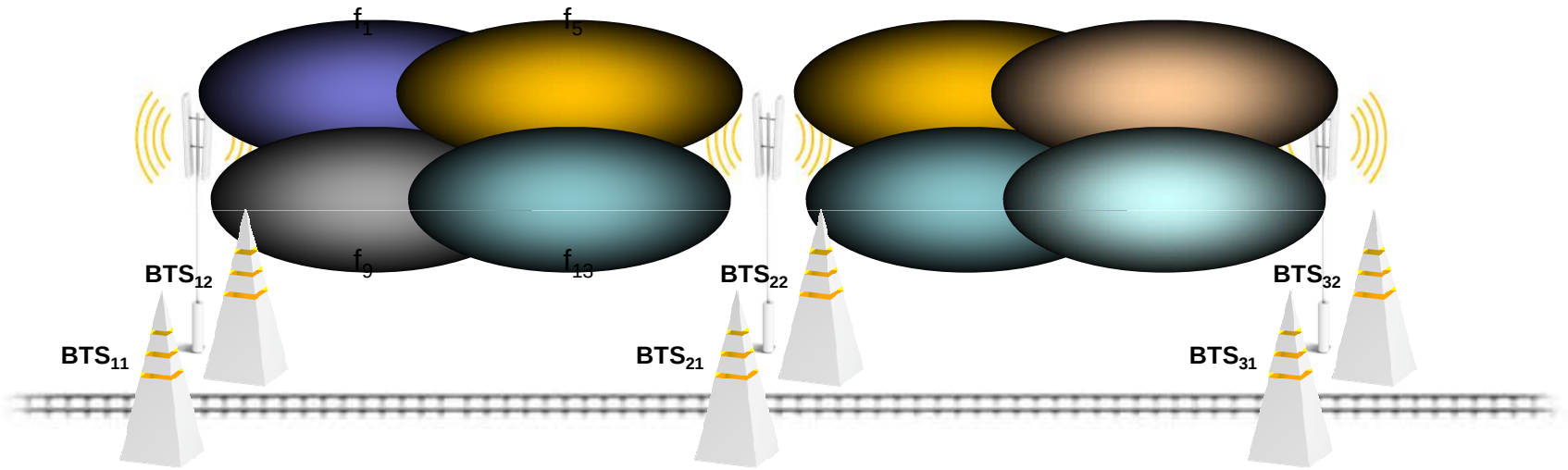
A specific configuration for railways exists



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

Configurations and Features

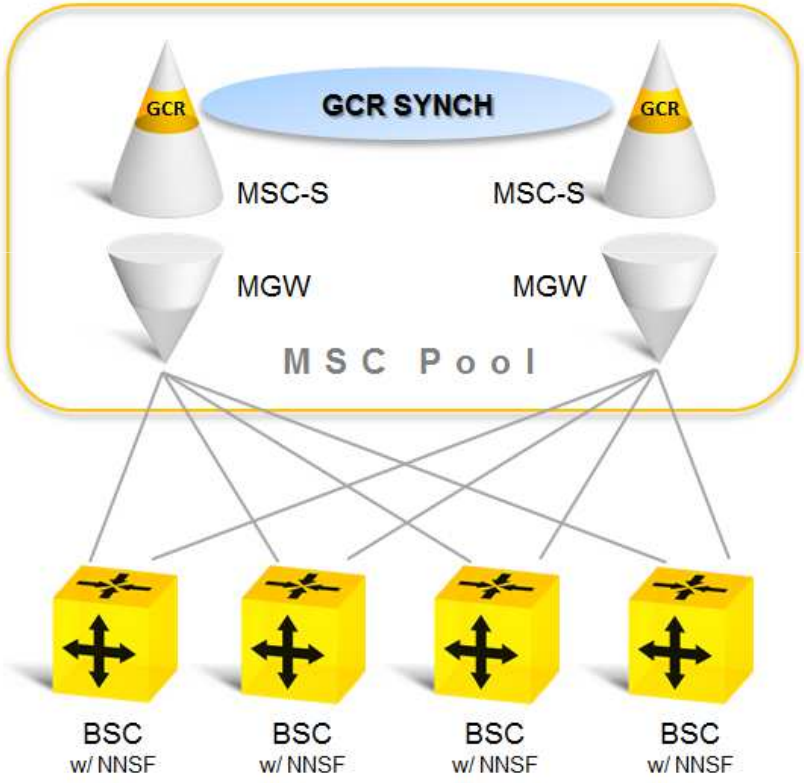
A specific configuration for railways exists: **double layering radio coverage**



- 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

Configurations and Features cont'd

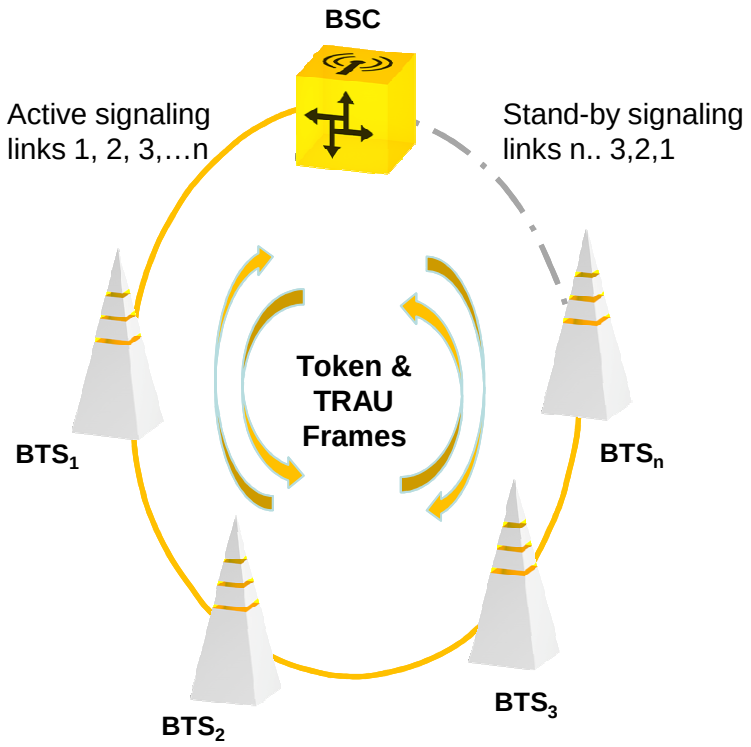
An example for interaction of access and core: **RAN Flex with GCR Redundancy**



- 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

Configurations and Features cont'd

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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Thank you !