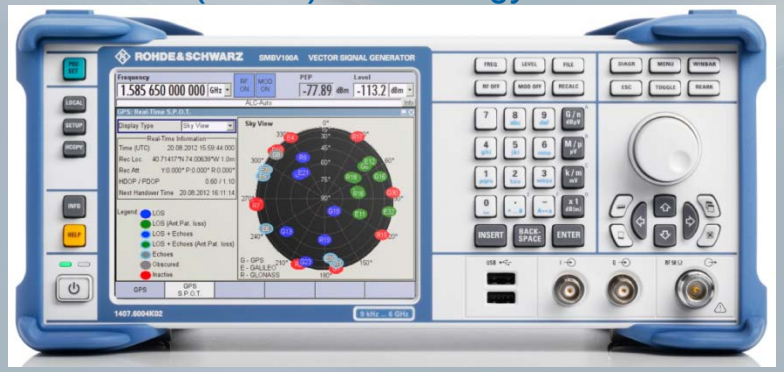
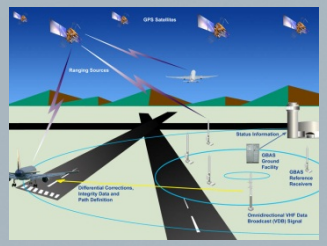
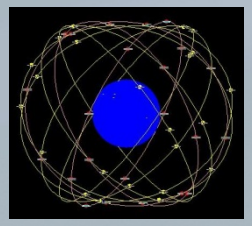
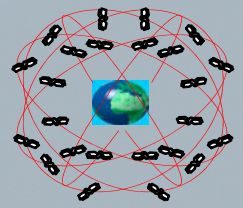
测试GNSS及LBS终端
确保更加满意的应用

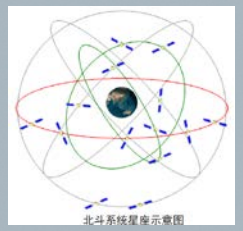
汤日波
Ribo Tang
罗德与施瓦茨（中国）科技有限公司
Rohde & Schwarz (China) Technology Ltd.

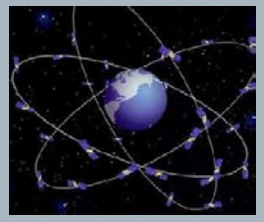












ROHDE&SCHWARZ

- **关于罗德与施瓦茨公司**
- GNSS及LBS定位技术
- GNSS 及LBS 测试挑战及要求
- GNSS 及LBS 测试方案
- 总结

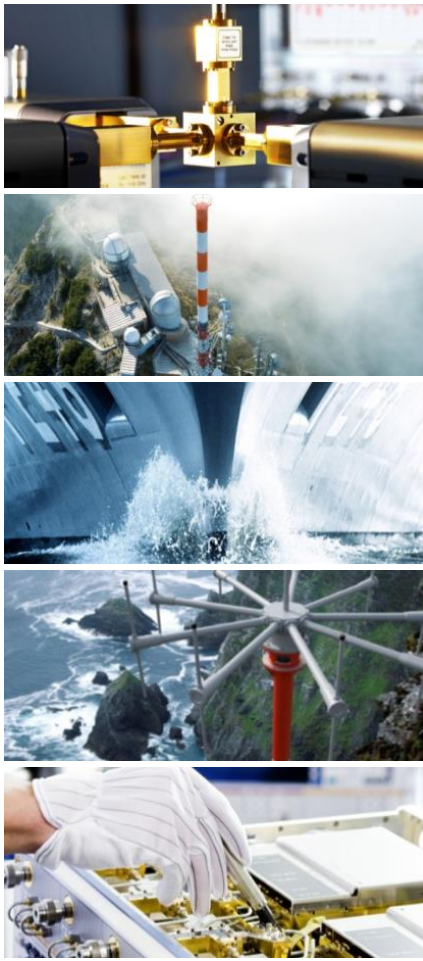
ROHDE&SCHWARZ

罗德与施瓦茨一览

- 1933年成立于德国，慕尼黑
- 独立、自治的公司
- 在70多个国家和地区设有代表机构，在60个国家和地区设有子公司
- 年营业额：约17.5亿欧元（2013年7月至2014年6月）
- 出口份额：约90%
- 全球9800名雇员，德国本土约5900名雇员
- 成就：在所有业务领域保持领先

全球化解决方案

- **无线通信**
  市场上每两部手机中至少有一部手机的研发和生产采用R&S测试解决方案
- **广播电视**
  为80多个国家提供广播电视发射机
- **空中交通管制**
  为200多个机场和空中交通管制中心提供无线电通信设备
- **安全通信**
  为全球陆海空部队提供军用无线电通信系统
- **频谱管理**
  为150多个国家提供无线电监测与定位设备及系统



- 关于罗德与施瓦茨公司
- **GNSS及LBS定位技术**
- GNSS 及LBS 测试挑战及要求
- GNSS 及LBS 测试方案
- 总结

ROHDE&SCHWARZ

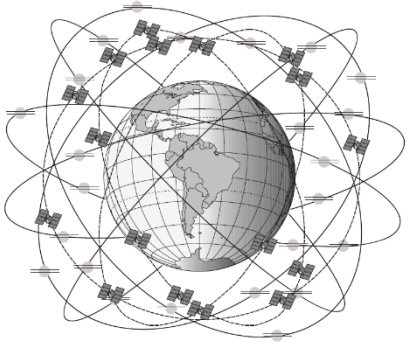
他/我在哪里?

LBS – 采用不同的技术定位

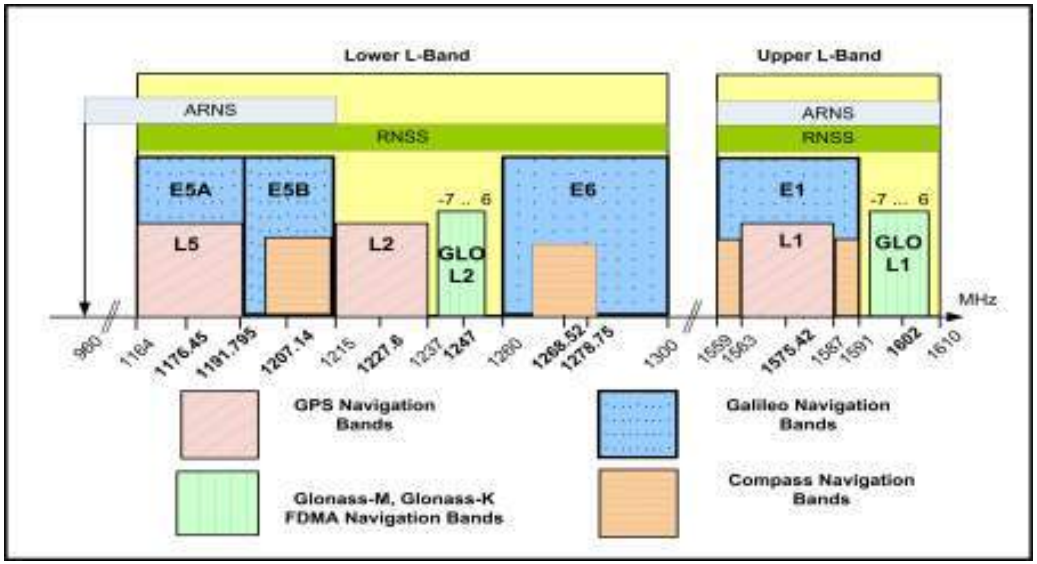
- 基于卫星的定位
  - GNSS such as GPS, GLONASS，BDS， …)
- 基于移动终端的定位
  - OTDOA
  - eCID
- 混合定位
  - 结合了:
    - 卫星定位
    - 手机定位

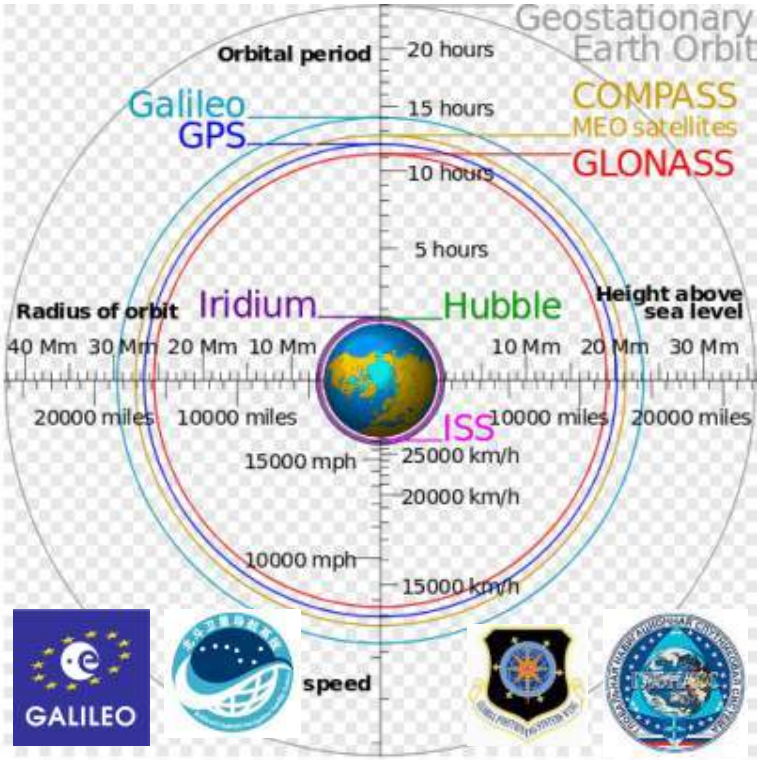
GNSS 全球卫星定位系统

*G*lobal *N*avigation *S*atellite *S*ystem



- GNSS (global navigation satellite system) 包括
  - GPS （Global Positioning System)，美国
  - GLONASS ,俄罗斯
  - BDS/北斗导航系统，中国
  - Galileo，欧盟
  - IRNSS (India, in process of planning)

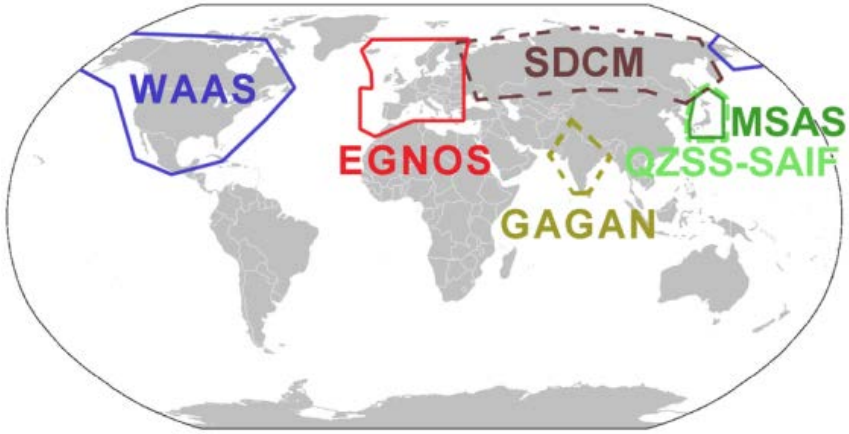




GNSS 卫星导航增强系统

SBAS – Satellite Based Augmentation Systems 星基增强系统

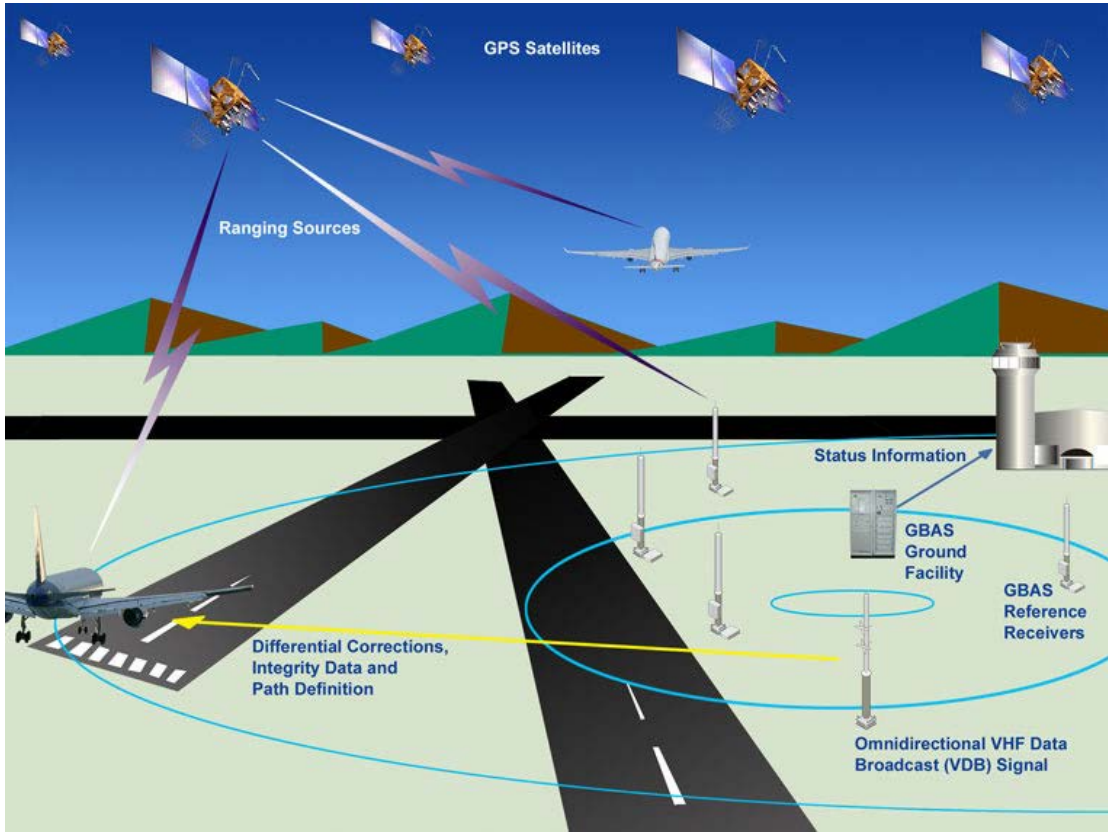
- WAAS – Wide Area Augmentation System (USA)
- EGNOS – European Geostationary Navigation Overlay Service (Europe)
- MSAS – Multi-Functional Satellite Augmentation System (Japan)
- QZSS – Quasi-Zenith Satellite System (Japan)
- GAGAN – GPS Aided Geo Augmented Navigation (India)



GNSS 卫星导航增强系统

GBAS Ground-Based Augmentation System地基增强系统

- Civil-aviation safety-critical system for local augmentation of the primary GNSS constellation(s)
- Airport level
- Enhanced levels for all phases of approach, landing, departure and surface operations
- Also called Local Area Augmentation System (LAAS)

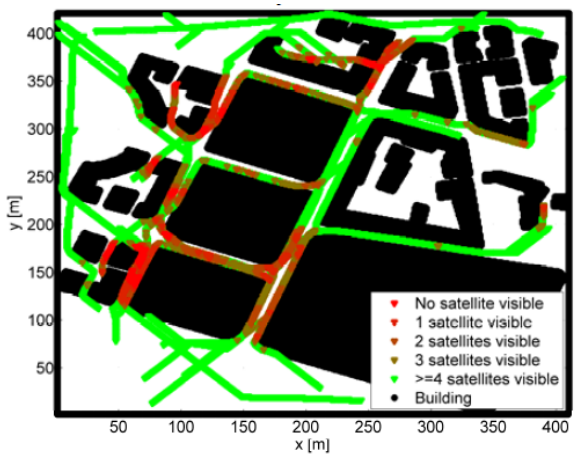


Source: FAA

GNSS足够了吗?

Critical scenario

Very critical scenario



GPS Satellites visibility (Urban)

Global navigation satellite systems (GNSSs)	• have restricted performance in certain environments
有时看不到4颗卫星	• critical situation for GNSS positioning • support required (Assisted GNSS) • alternative required (Mobile radio positioning)
HDOP	• for satellite systems are bad and need to be enhanced by OTDOA and ECID measurements

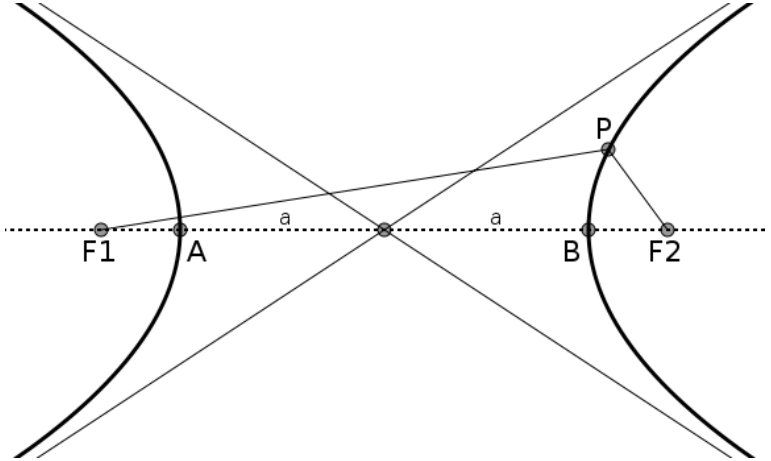
A-GNSS 辅助卫星定位

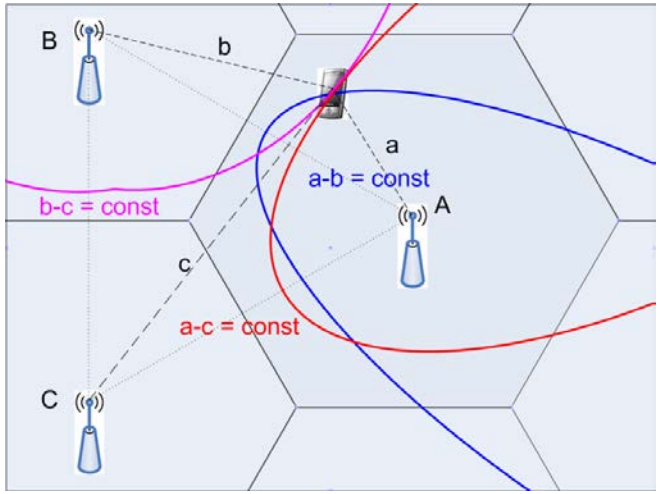
- 网络辅助改善GNSS接收机的性能：
  - 大大减少GNSS开机启动时间.
  - 提高GNSS灵敏度, 减少功耗.

- 2种工作模式
  - **手机辅助模式**
    - Device (= User Equipment, UE) transmits GNSS measurement results to network server, where position calculation takes place.
  - **基于手机模式**
    - UE performs GNSS measurements and position calculation, supported by:
      - Data to assist these measurements, e.g. reference time, visible satellite list etc.
      - Data providing for position calculation, e.g. reference position, satellite ephemeris, etc.

OTDOA 到达时间差

- OTDOA = Observed Time Difference of Arrival
- UE positioning estimated based on:
  - measuring TDOA of DL (PRS) signals received from different eNB-s
    - each TDOA measurement describes a hyperbola (line of constant difference 2a), the 2 focus points of which (F1, F2) are the two measured eNB-s (PRS sources), and along which the UE may be located.
    - UE's position = intersection of hyperbolas for at least three pairs of eNB-s (= 3 eNB-s)
  - knowledge of the geographical coordinates of the measured eNode Bs





eCID

- E-CID = Enhanced cell ID
- UE position accuracy CID is specified more accurately using additional UE and/or eNB radio measurements:
  - E-CID with Distance from serving eNB (Fig.1) → Position accuracy a circle
    - Distance calculated by measuring RSRP / TOA / TADV (RTT)
  - E-CID with Distances from 3 eNB-s (Fig.2) → Position accuracy a point
    - Distance calculated by measuring RSRP / TOA / TADV (RTT)
  - E-CID with Angels of arrival (Fig. 3) → Position accuracy a point
    - AOA are measured for at least 2, better 3 eNB-s

Fig.1

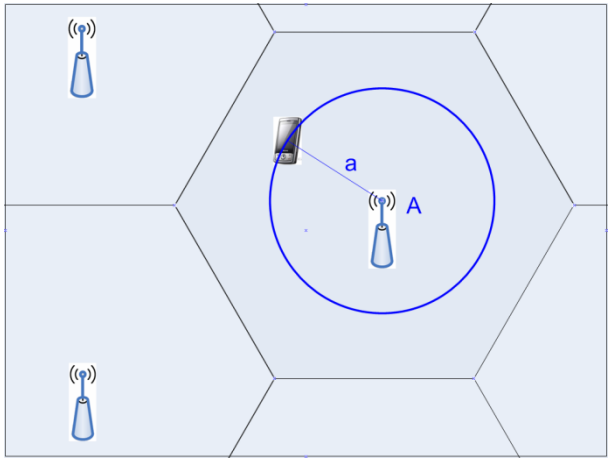


Fig.2

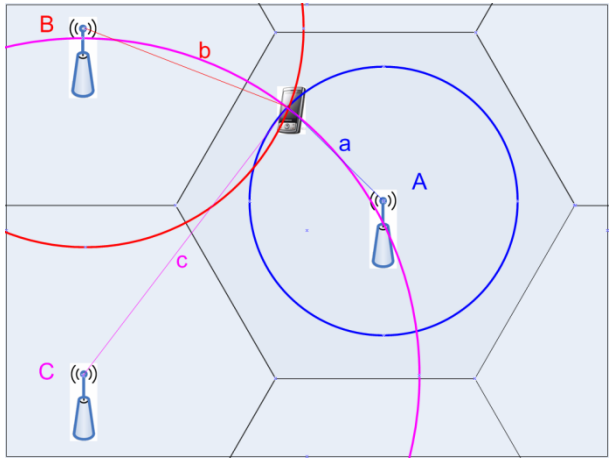
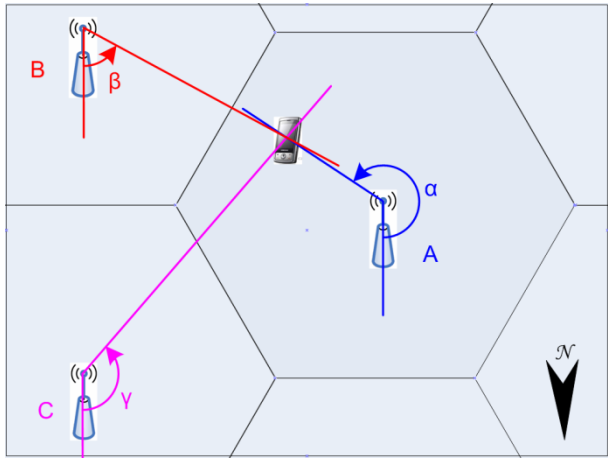
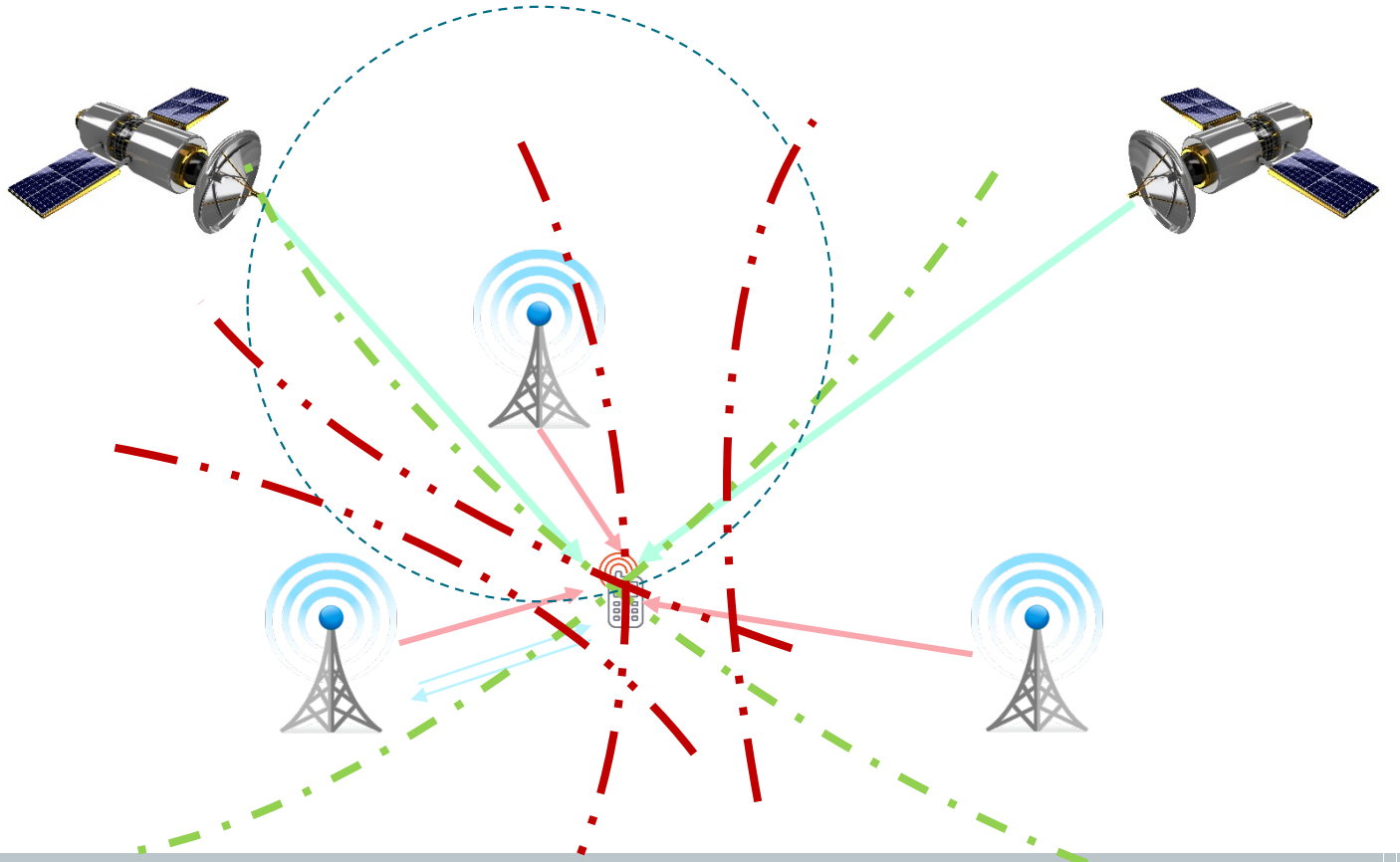


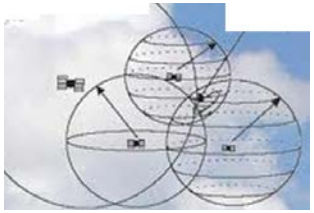
Fig.3



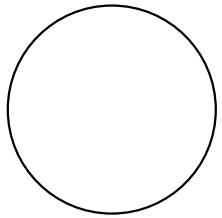
LBS-Hybrid 混合定位

- Combine LBS measurements from different sources to obtain the most accurate positioning solution (GNSS + OTDOA + ECID + …)

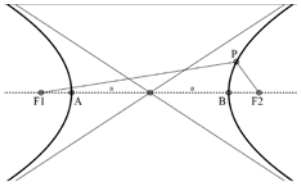




GNSS



eCID



OTDOA

- 关于罗德与施瓦茨公司
- GNSS及LBS定位技术
- **GNSS 及LBS 测试挑战及要求**
- GNSS 及LBS 测试方案
- 总结

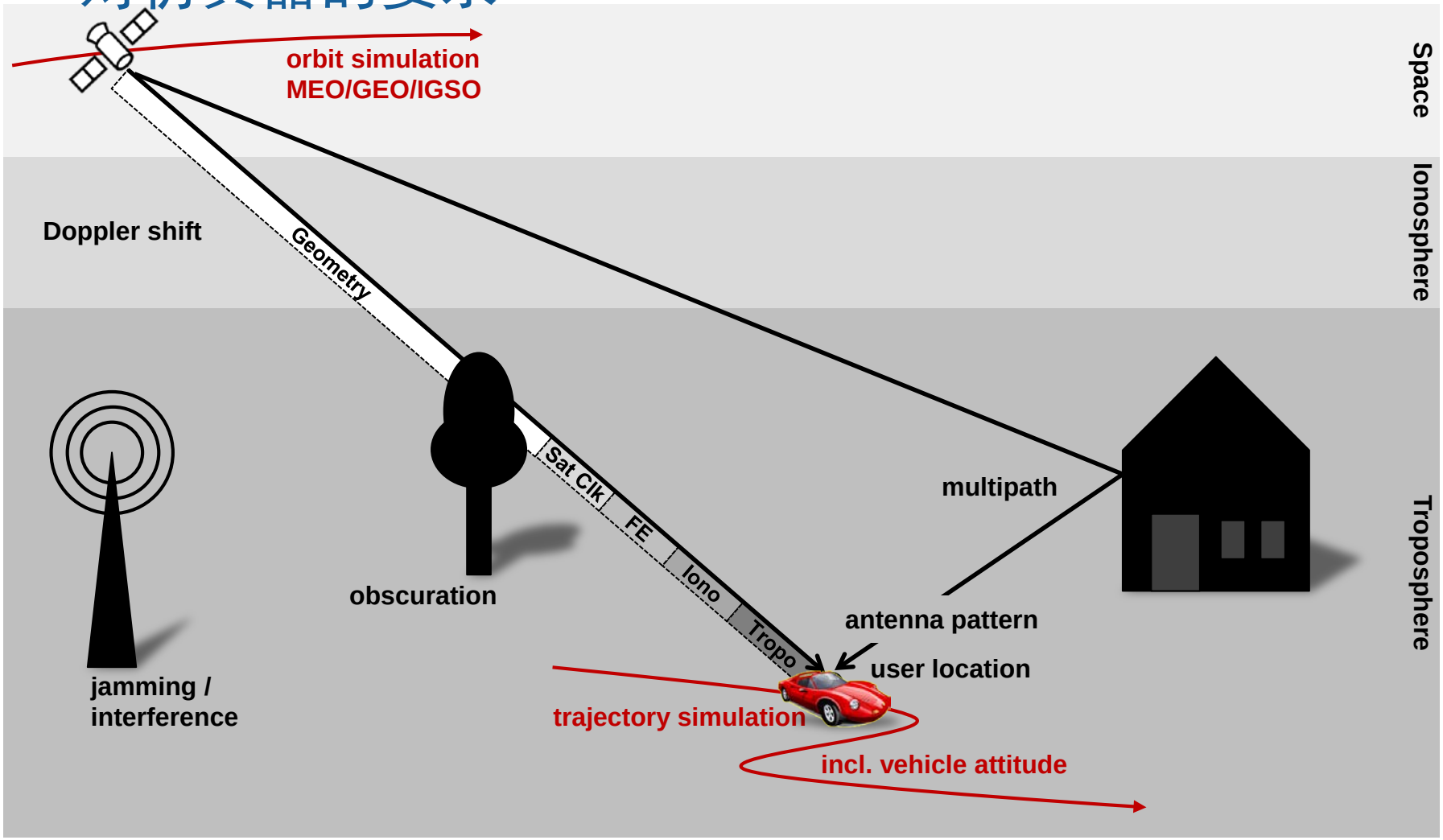
ROHDE&SCHWARZ

导航卫星信号模拟器

- 模拟真实环境下GNSS接收机收到的卫星导航信号
- 实验室环境下测试的优点
  - 可重复性
  - 可控性
  - 准确性
  - 极限性能测试
- 可以为每个测试项目提供非常稳定的测试环境(初次捕获时间、准确度、灵敏度…)
- 可以模拟灵活可变的测试 场景(卫星数目,卫星功率, 地理位置, 大气参数) 用于性能测试

GNSS的各种场景

——对仿真器的要求



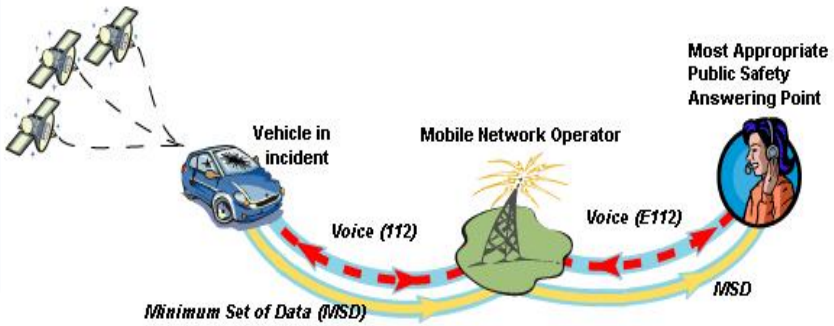
GNSS接收机常规测试项目

- 冷启动、温启动、热启动状态下的初次定位时间
- 灵敏度
- 再次捕获时间
- 抗干扰测试
- 衰落多径测试
- 电离层和对流层不同参数环境下的测试

移动终端LBS –应用场景

公共安全

- **FCC E911 对定位精度的要求**
  - **Carriers must provide location, confidence and uncertainty data for all emergency calls**
  - **terminal based positioning**
    - 67% of all calls must be within 50m
    - 95% of all calls must be within 150m
  - **network based positioning**
    - 67% of all calls must be within 100m
    - 95% of all calls must be within 300m
- **欧洲 eCall的要求**



地图和定位

- **e.g. routing to an address, to next ATM**

导航跟踪

- **e.g. finding friends / family, vehicle tracking**

信息服务

- **e.g. City Guides, Mobile yellow pages**
- **Future trend: augmented reality**

移动终端LBS的测试要求

Test Requirements:

- FCC E911强制性测试要求
- GCF / PTCRB / OMA 认证
- 网络运营商的入网要求
- OTA 性能测试要求
- 研发 LBS 的测试要求

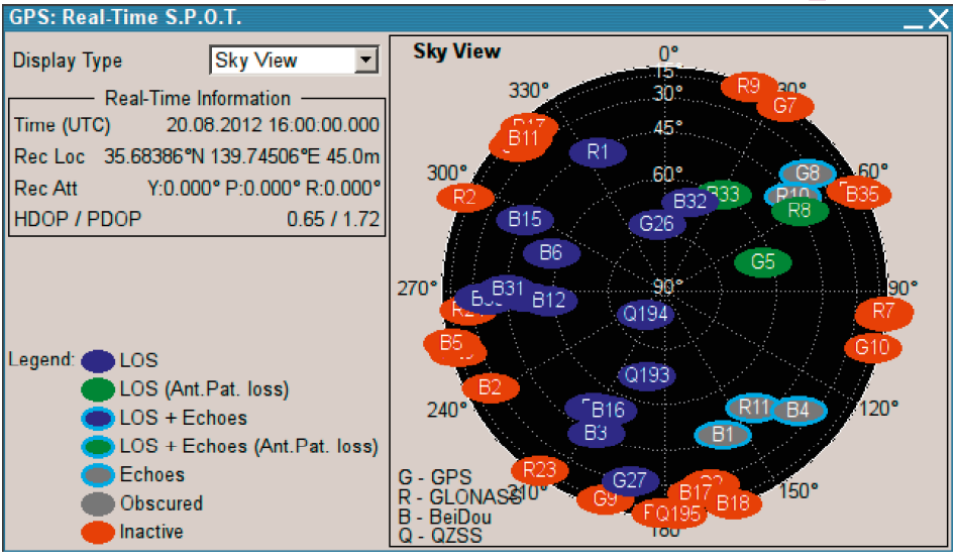
at&t

- 关于罗德与施瓦茨公司
- GNSS及LBS定位技术
- GNSS 及LBS 测试挑战及要求
- **GNSS 及LBS 测试方案**
- 总结

ROHDE&SCHWARZ

信号发生器SMBV100A

GNSS模拟器



- 支持GPS,GALILEO, GLONASS, BDS B1+B2, QZSS, SBAS, GBAS
- 单台仪表最多支持24颗卫星
- 每颗导航卫星的幅度精确可调
- 支持移动场景测试
- 可以加载“多径衰落”场景

……

SMBV100A中的GNSS模拟器

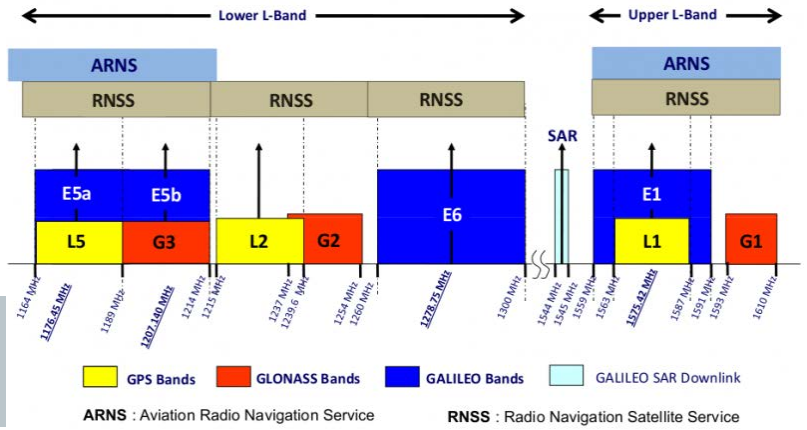
Supported GNSS	
GPS	✓
Galileo	✓
Glonass	✓
Compass/BeiDou	✓
Simulation of hybrid const.	✓

Supported signals	
GPS L1 C/A + NAV	✓
GPS L1 C/A + NAV + P-Code	✓
GPS L2 C/A + NAV	✓
GPS L2 C/A + NAV + P-Code	✓
Galileo E1 CBOC	✓
Glonass G1	✓
Glonass G2	✓
Compass/BeiDou B1, B2	✓
GBAS,SBAS,QZSS	✓

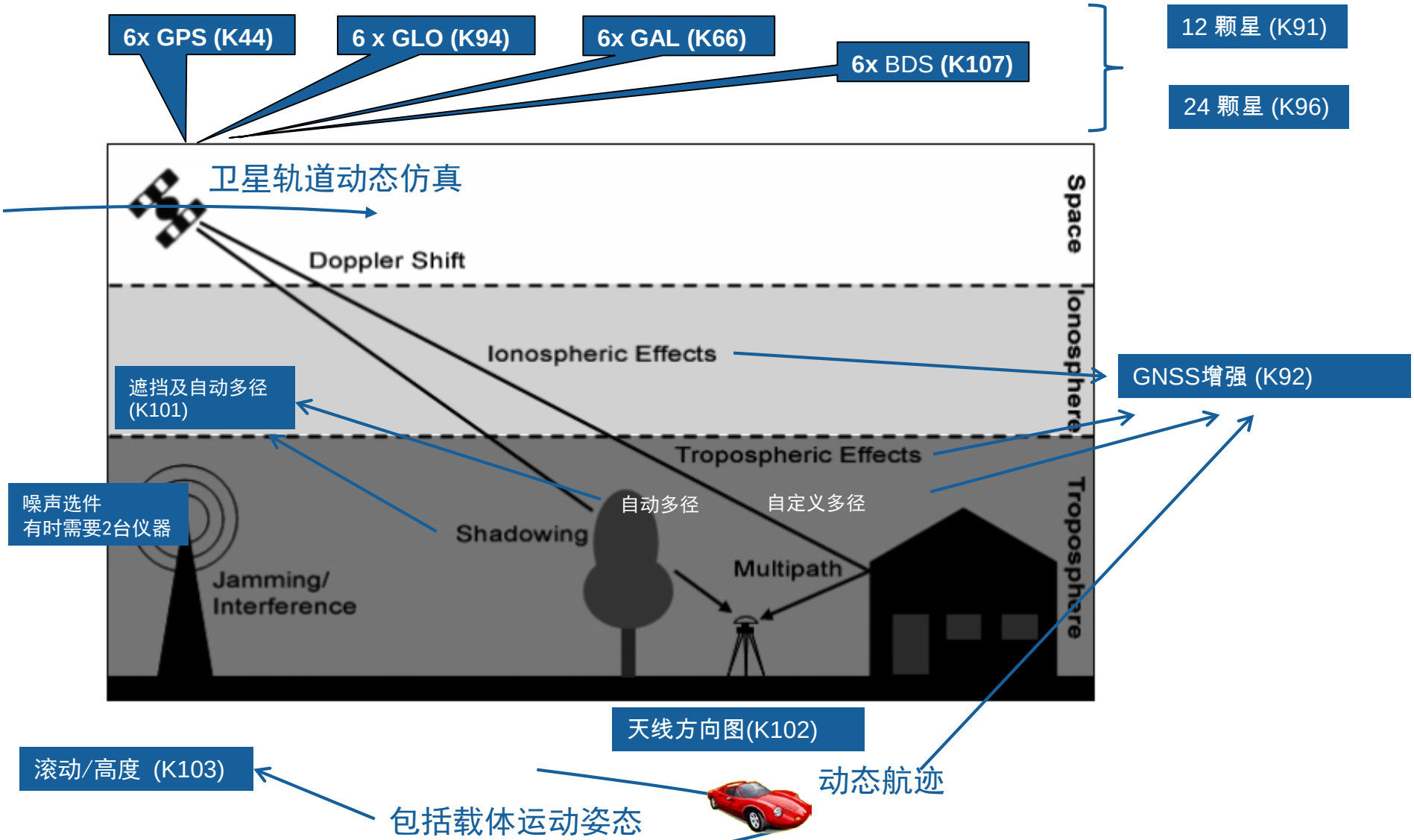
Signal dynamics	Standard	Optional
Max. velocity	599 m/s	10000 m/s
Max. acceleration	1600 m/s²	
Max. jerk	400 m/s³	

Enables a multitude of applications
(pedestrian, automotive, aerospace, defense, space)

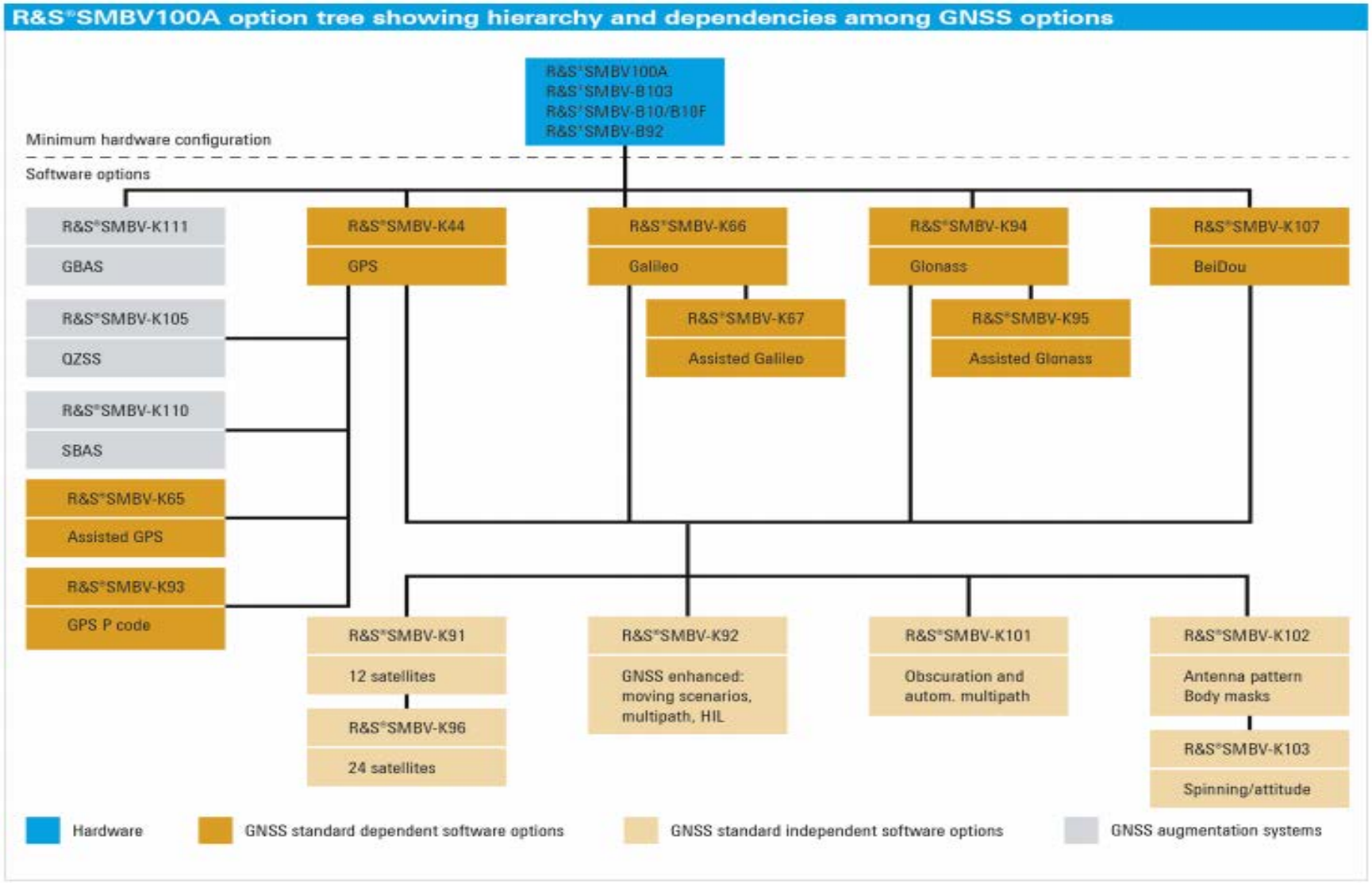
Channels/Frequencies	
No. of channels	24
No. of channels per system	24
No. of supported frequencies	2
Simultaneous sim. of multiple freq.	✓ (2 instr.)



SMBV100A对现实的仿真



SMBV100A GNSS选件



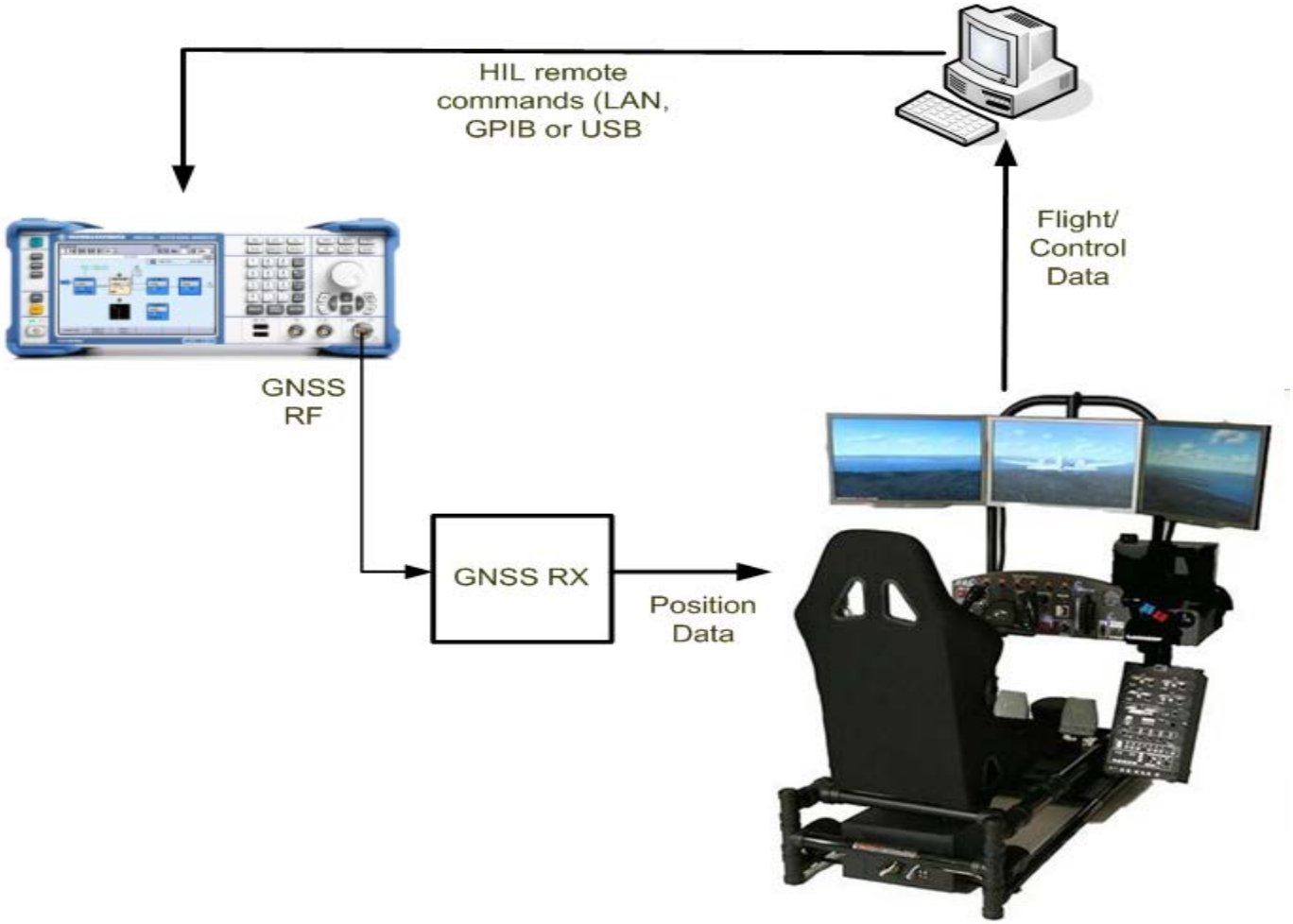
SMBV100A 北斗选件

SMBV-K107

- 最多仿真24 颗北斗卫星 ， B1,B2频段
- 静态模式和定位模式
- 带导航数据的用户可定义的星历文件
- MEO/IGSO 和GEO星的D1 和D2消息,
- 用户自定义的位置和开始时间
- 自动设置优化星系的北斗场景
- 无限制自动仿真时间，空中卫星飞行切换
- 实时对每颗卫星进行动态功率控制
- 混合 GNSS 星系仿真，最多 6 颗星 (R&S®SMBV-K44 GPS, R&S®SMBV-K66 Galileo and/or R&S®SMBV-K94 Glonass option)

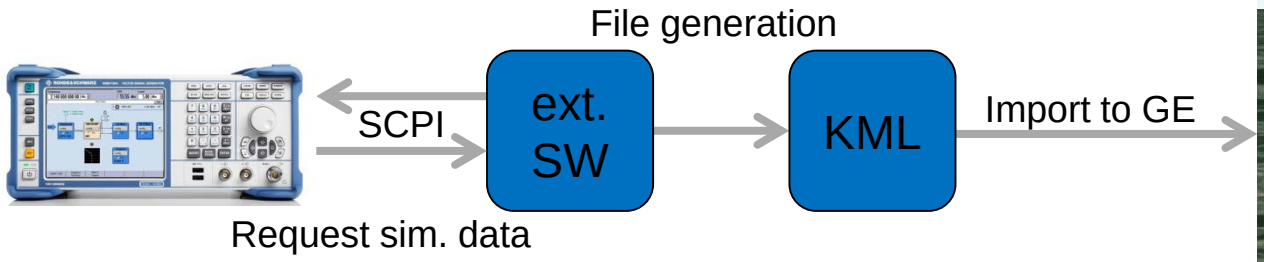
SMBV100A 测试案例：硬件在环测试

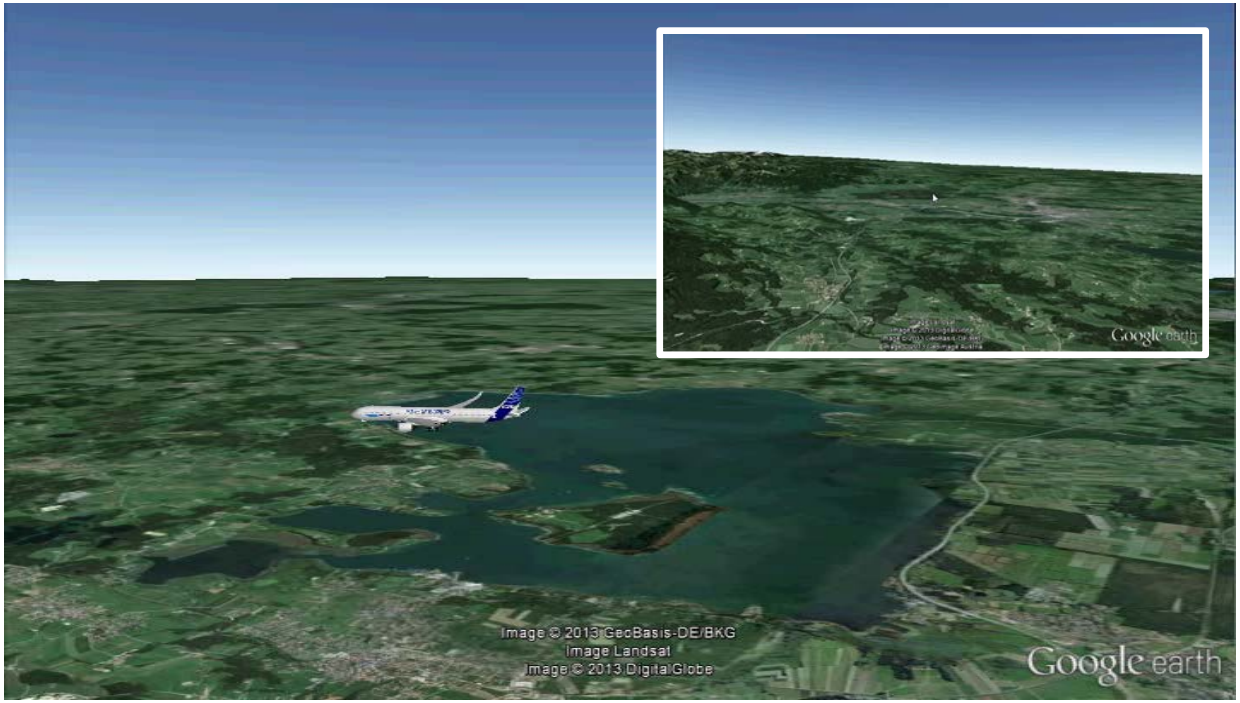
飞行模拟器

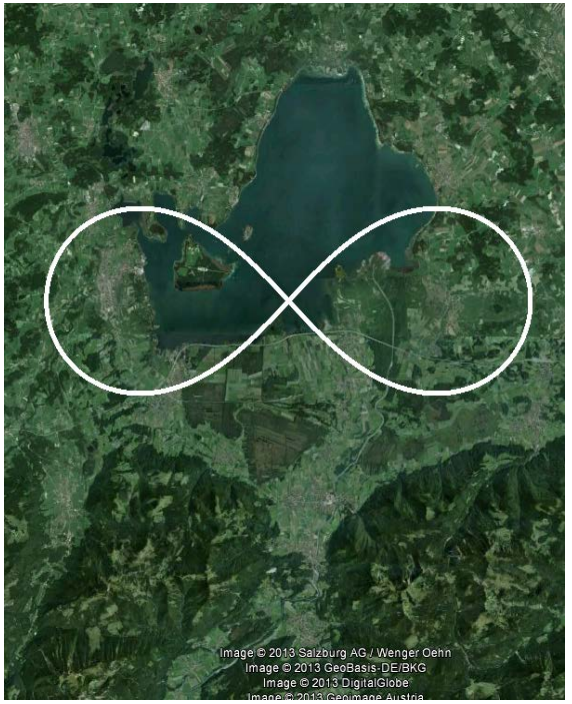


SMBV100A 测试案例：仿真 GNSS场景的测试

Putting it all together…

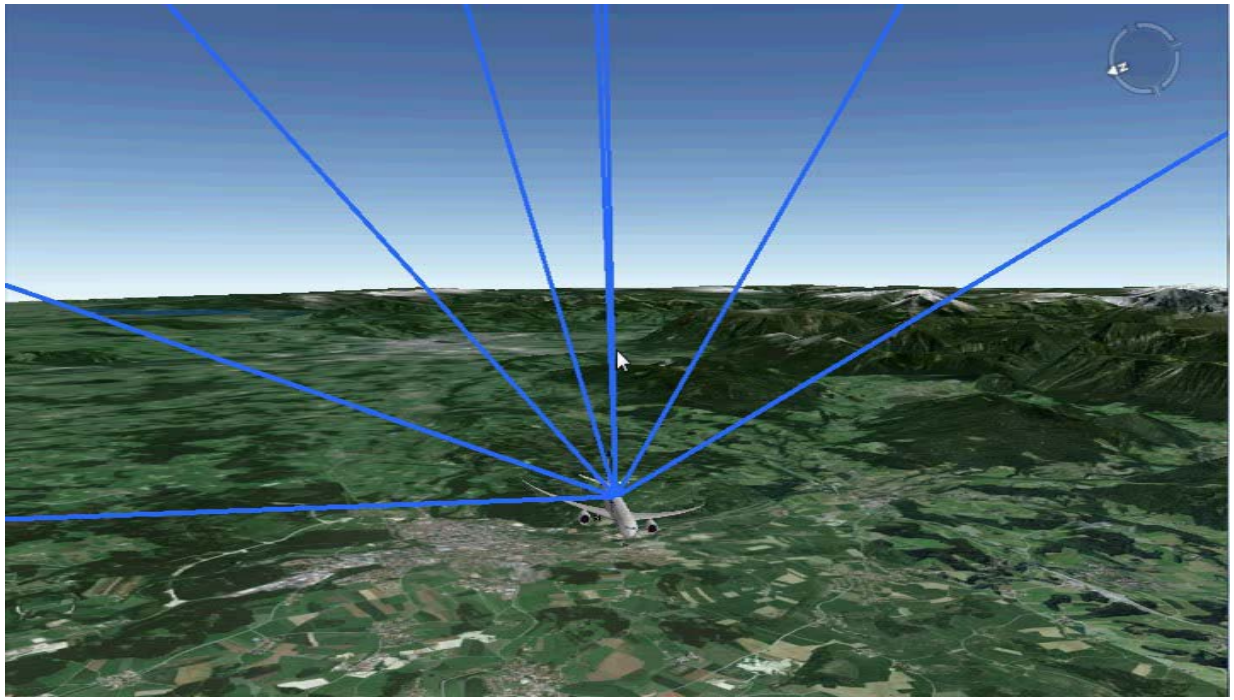


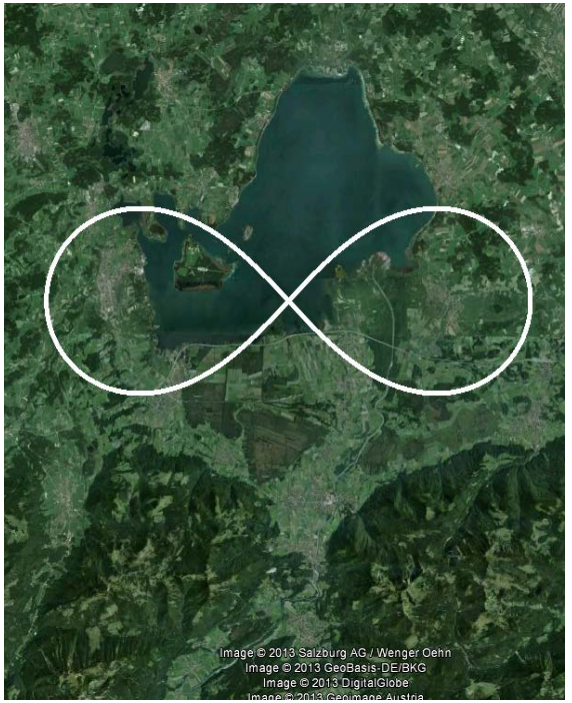




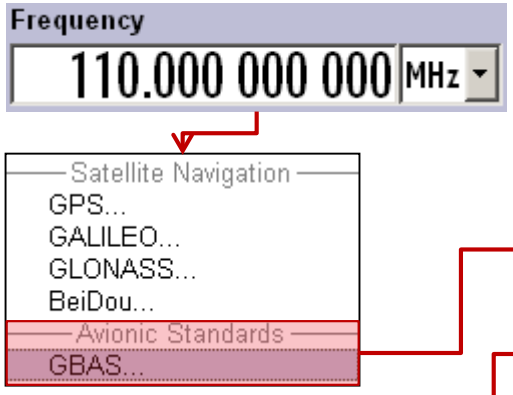
SMBV100A测试案例：仿真GNSS场景

Putting it all together…

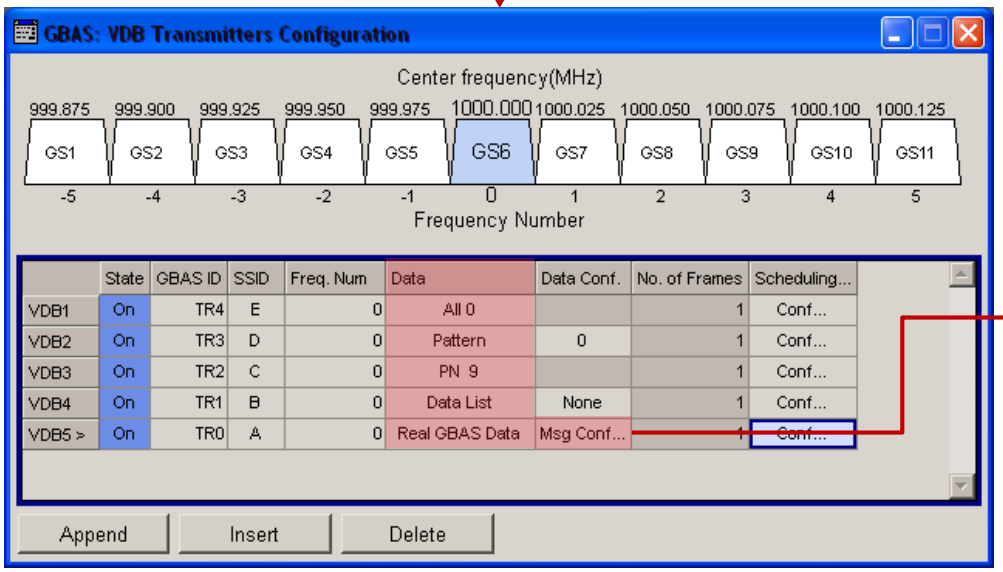




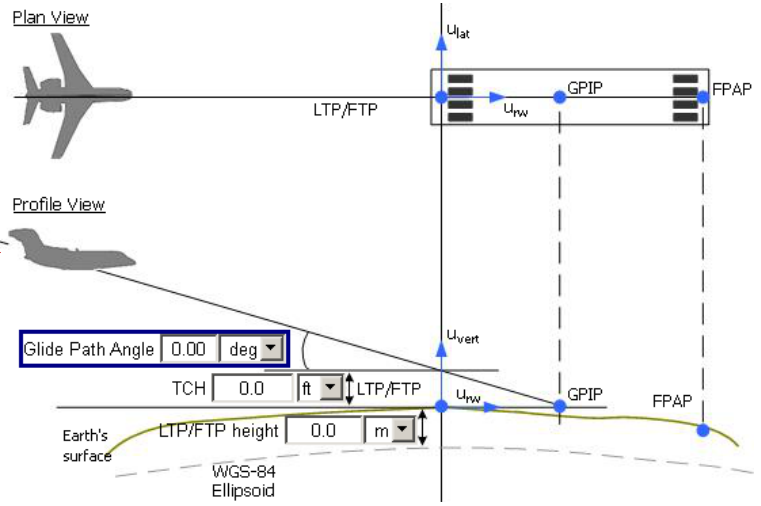
SMBV100A中的GBAS仿真器



Set frequency between 108 MHz and 118 MHz

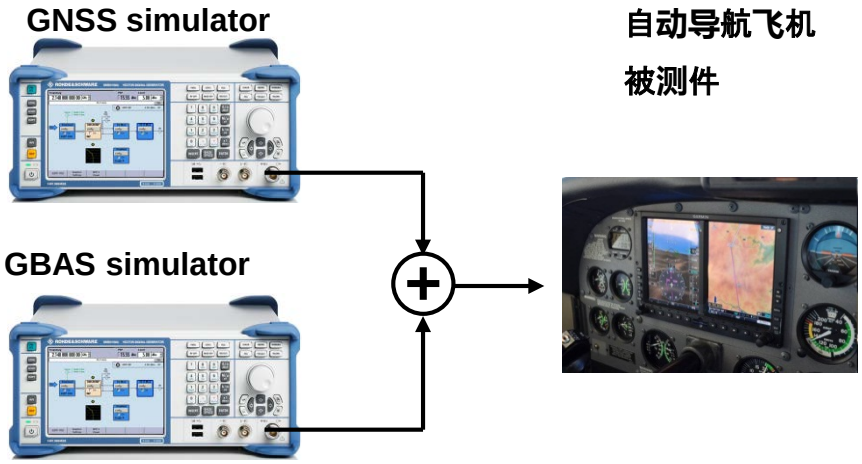


Even more GBAS-related configuration options…



SMBV100A组成的GBAS测试系统

- 1 台 SMBV100A 模拟 GNSS
- 1 台 SMBV100A 模拟 GBAS 发射
  - Differential data must be generated before and transferred to SMBV 2 for packaging it into the GBAS message

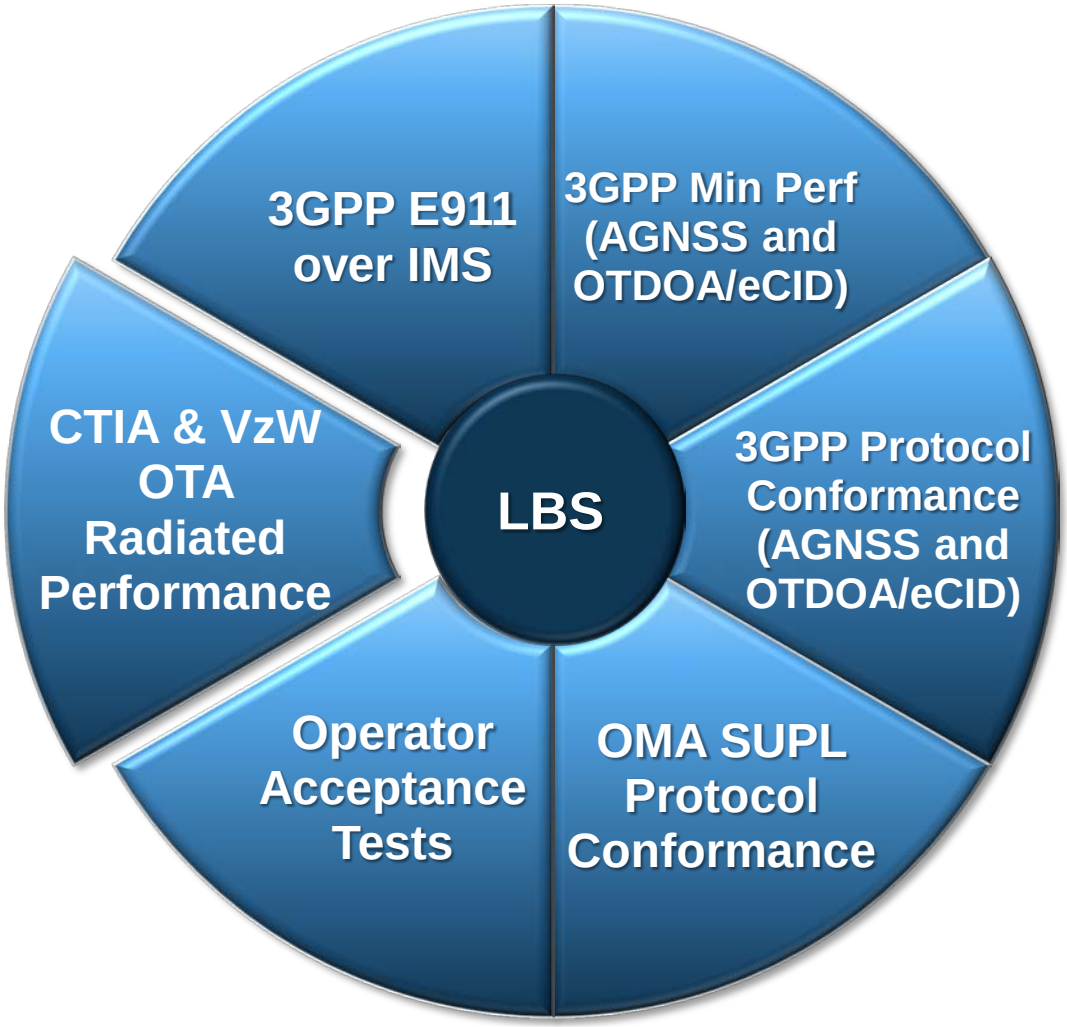


LBS的测试要求

Test Requirements :

- FCC E911 mandate
- GCF / PTCRB / OMA
- Network Operator Acceptance
- OTA Performance Testing
- R&D LBS Testing

TS-LBS – 满足LBS的各种测试需要



TS-LBS

TS-LBS advanced

=(TS-RRM advanced + SMBV + IQR)

TS-LBS测试方案满足不同的需求

GNSS Testing (24 Channels)

TS-LBS

TS-LBS NetOP
(CMW-PQA +SMBV)

OTDOA + eCID Entry Point

TS-LBS advanced
(TS-RRM advanced)
(CMW-PQA CA setup)

TS-LBS advanced
(Complete 3GPP + NetOP)

OTA TS8991 Performance Test System +SMBV

LBS OTDOA/eCID

LBS A-GNSS LTE/WCDMA/GSM

Support by means of CONTEST…

GNSS 的测试有时需要更加真实的场景

Atmospheric influences

- Signal distortion
- Path delays

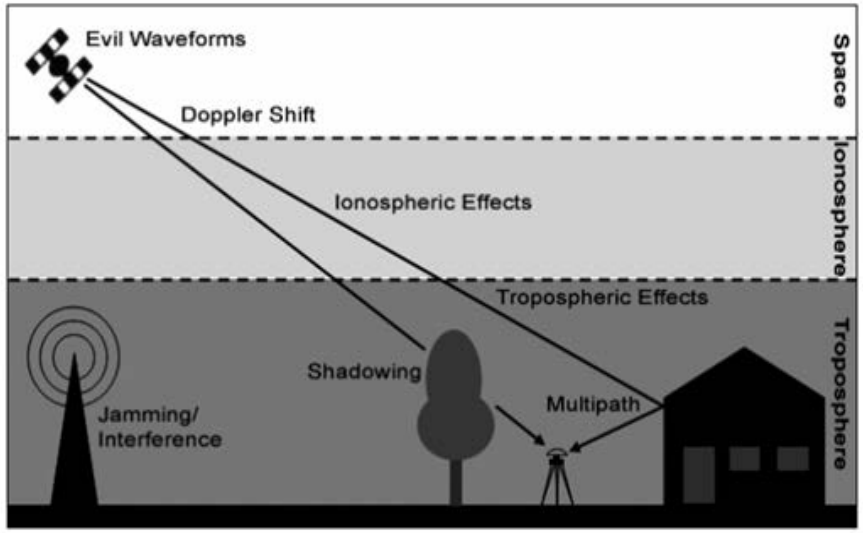
User environment:

- Multipath
- Signal obstructions and diffraction
- Jamming/interference
- GNSS receiver movement

Consequence

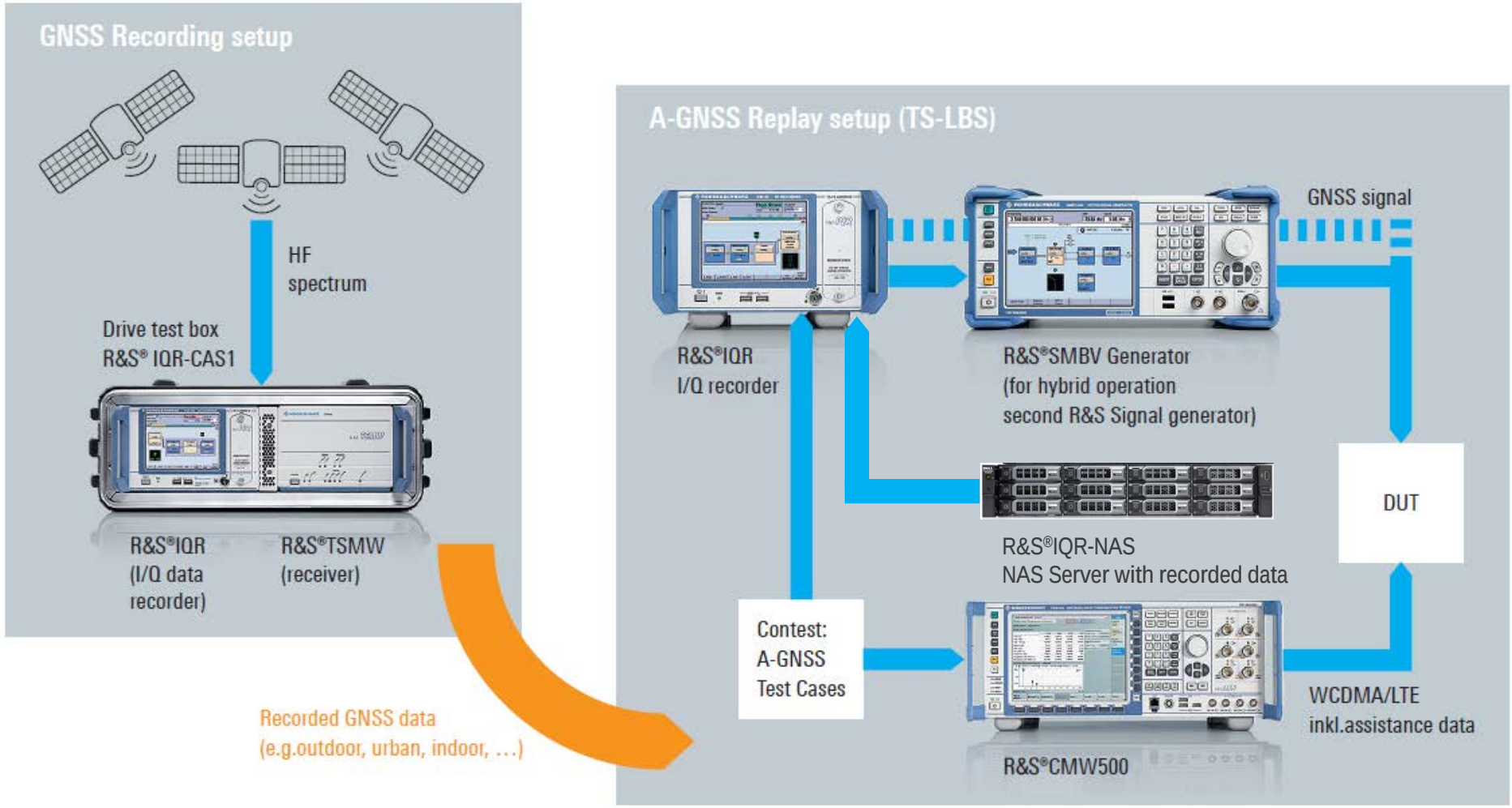
- Errors in time of arrival and signal strength
- Degraded location accuracy
- Degraded TTFF or degraded reacquisition time of the receiver.

如何在实验室中进行所有真实场景的模拟测试?

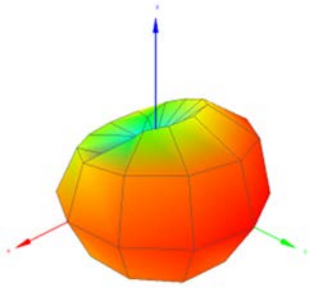


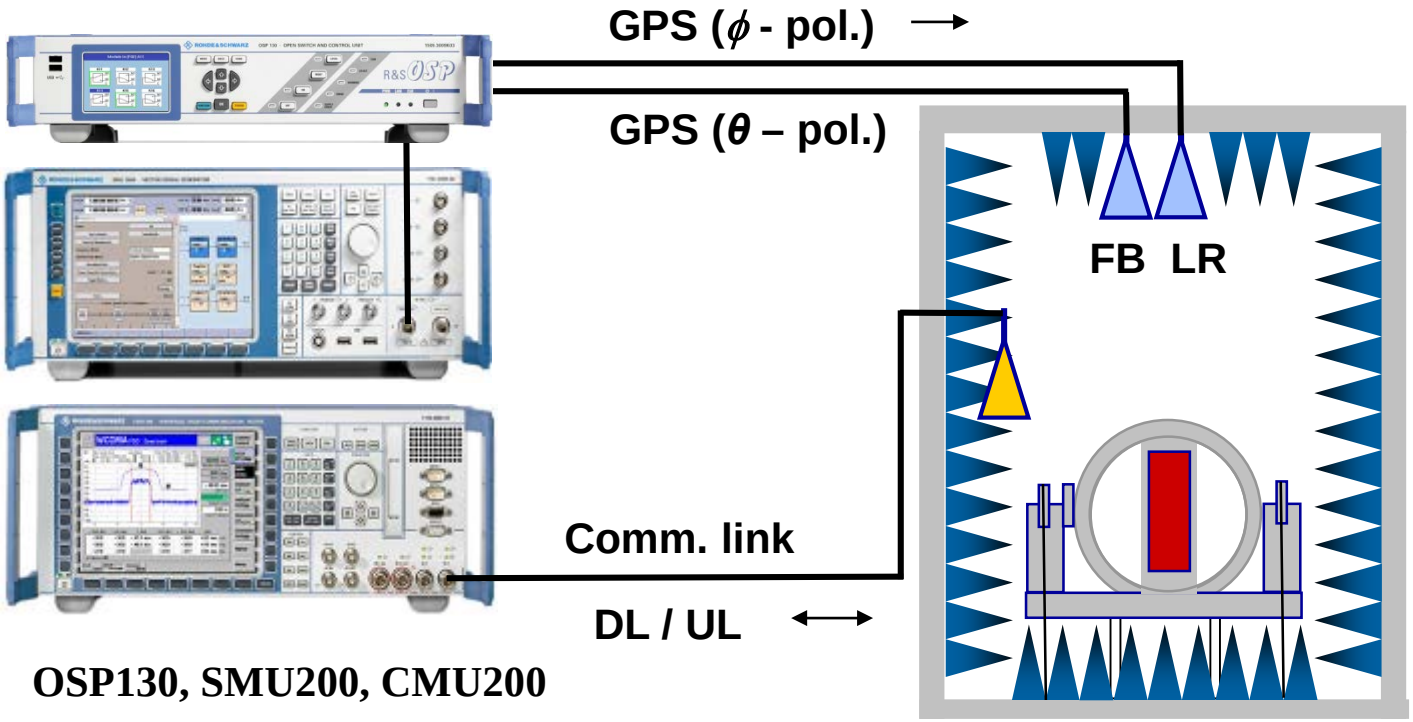
DUT

A-GNSS Field2Lab记录与回放测试方案



用于LBS OTA测试的DST200 测试小暗室





- 关于罗德与施瓦茨公司
- GNSS及LBS定位技术
- GNSS 及LBS 测试挑战及要求
- GNSS 及LBS 测试方案
- **总结**

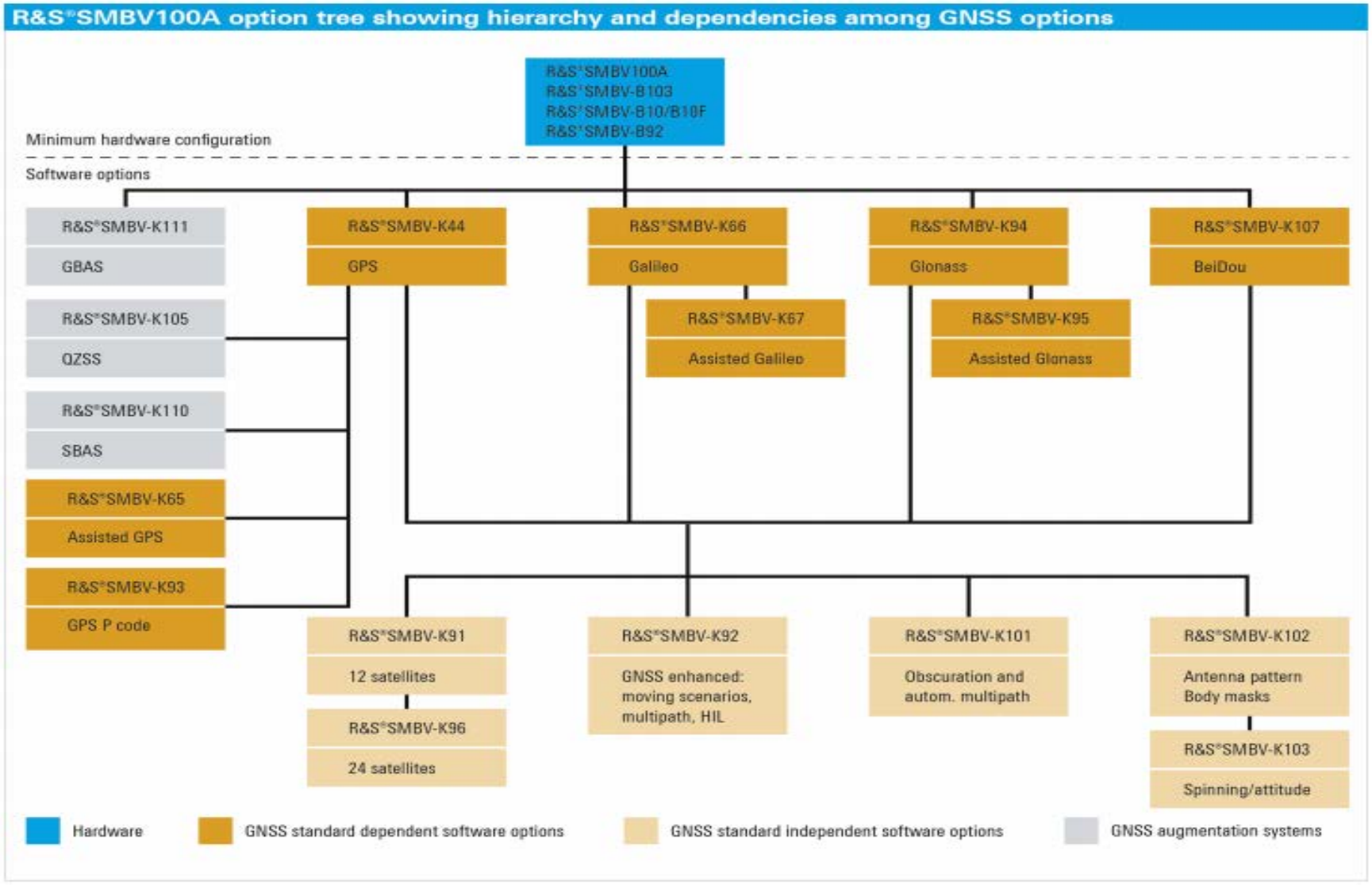
ROHDE&SCHWARZ

总结

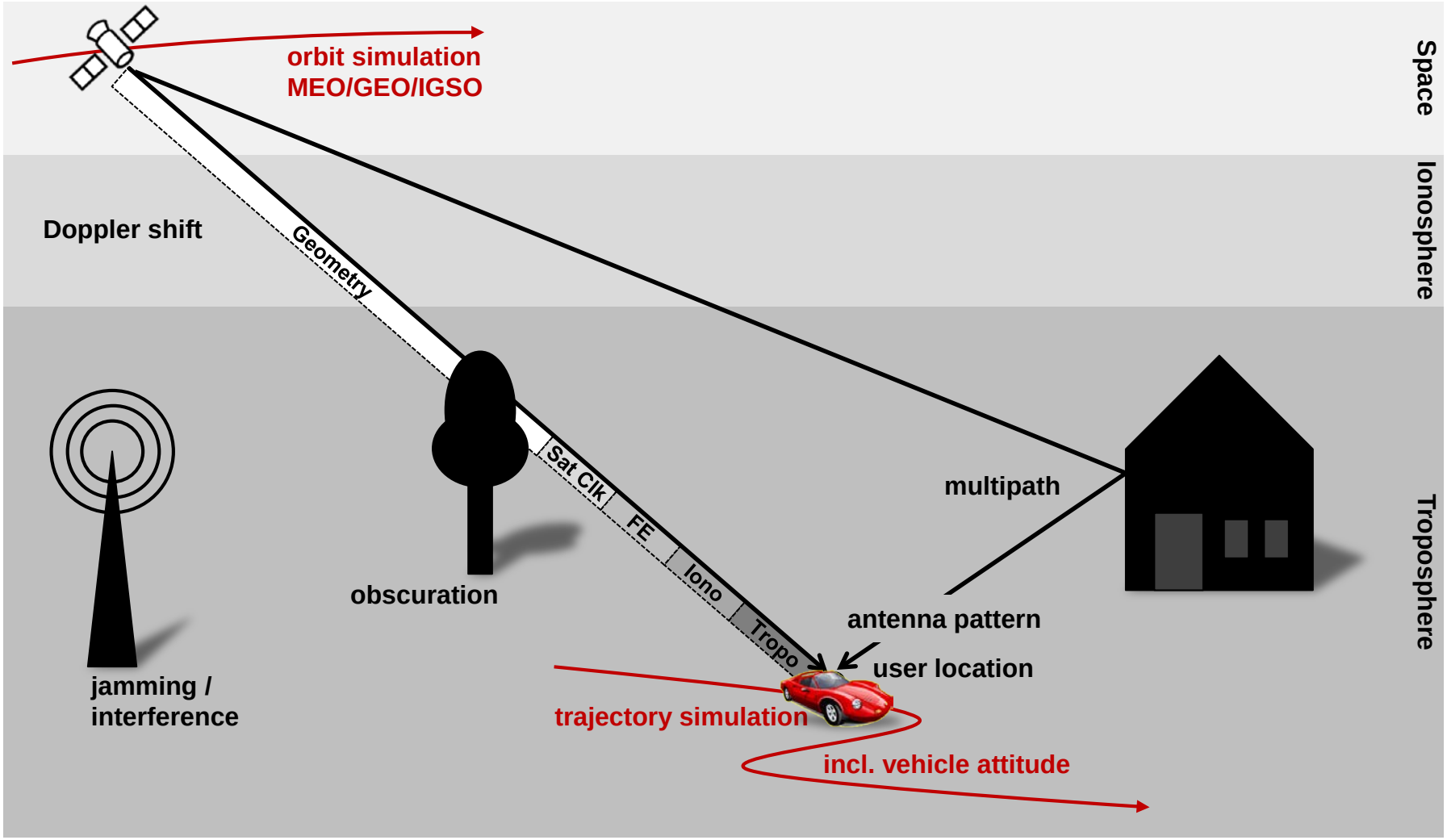
SMBV100A GNSS信号仿真源

- 支持GPS L1/L2的C/A代码P代码，GLONASS L1/L2、Galileo E1和北斗B1+B2，包括混合星座图
- 支持星基增强系统SBAS，QZSS； 支持陆基增强系统GBAS
- 实时模拟多达24颗卫星的实际星座，无限模拟时间
- 使用零频移或常量多普勒频移，进行静态基本接收机测试
- 实际用户环境：信号衰落失真和多径，天线特性和车辆情况
- 运动场景：动态功率控制和大气环境建模，高动态：最高10000m/s
- A-GNSS测试场景：生成GPS、Glonass、伽利略系统和北斗的辅助数据
- 支持硬件环路（HIL）测试，可实时输入外部航迹
- 高信号动态范围 ，各种载体运动姿态仿真，支持航天国防应用
- 支持GBAS着陆系统，支持SBAS增强系统及QZSS
- 支持各种数字通信信号（GSM, WCDMA, HSPA+, LTE, WiMAX, WLAN…）和各种无线电信号 （DAB, XM radio, HD radio, Sirius, FM stereo）

SMBV100A GNSS选件图



SMBV100A仿真各种 GNSS应用场景



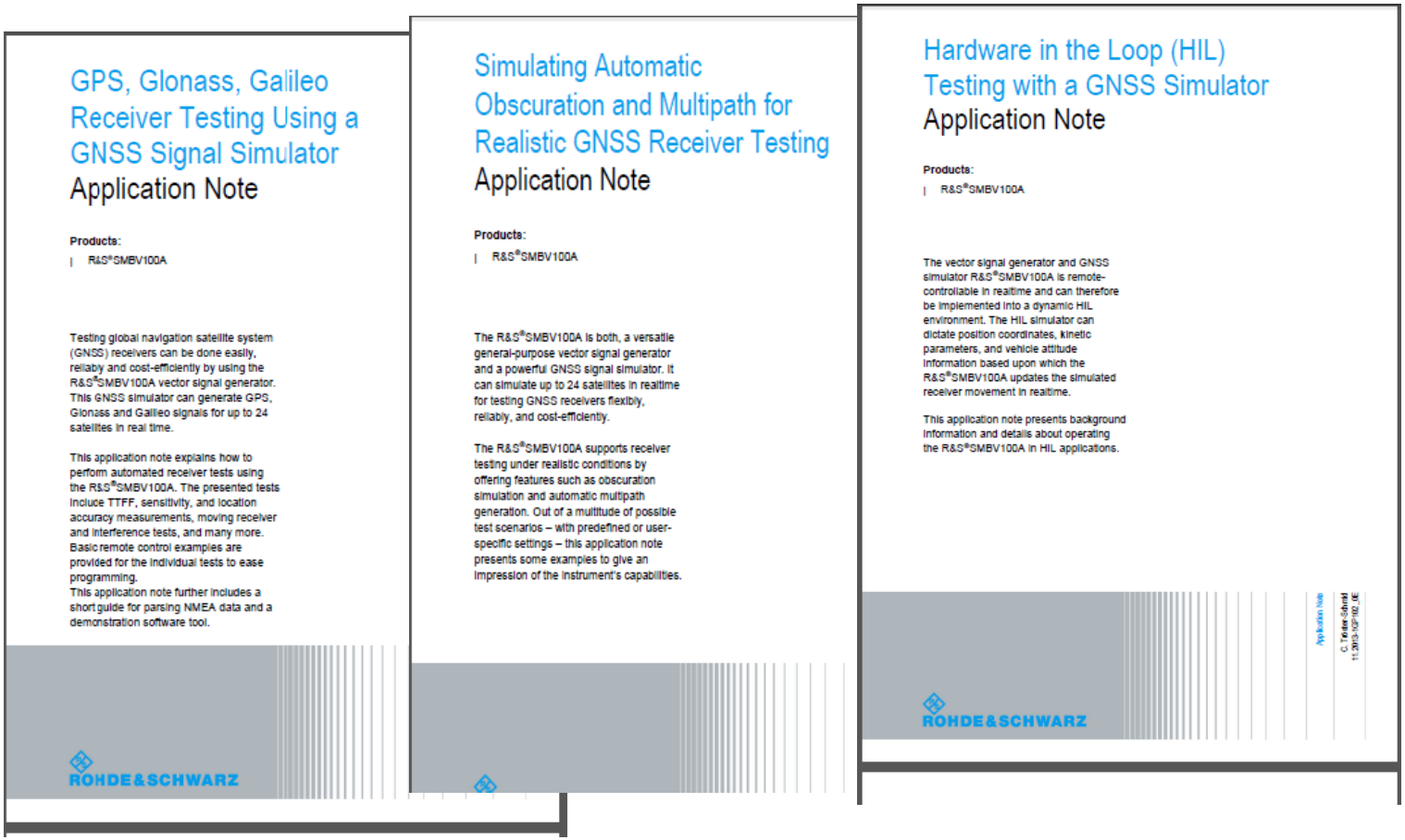
A-GNSS最低性能测试

Test description	GERAN A-GPS TS 51.010-1	GERAN A-GNSS TS 51.010-1	UTRAN FDD A-GPS TS 37.571-1	UTRAN FDD A-GNSS TS 37.571-1	E-UTRA A-GNSS TS 37.571-1
Sensitivity Coarse time assistance	70.11.5.1.	70.16.5.1.	5.2.1.	6.2.1.	7.1.1.
Sensitivity Fine time assistance	70.11.5.2.	70.16.5.2.	5.2.2.	6.2.2.	7.1.2.
Nominal accuracy	70.11.6.	70.16.6.	5.3.	6.3.	7.2.
Dynamic range	70.11.7.	70.16.7.	5.4.	6.4.	7.3.
Multipath scenario / performance	70.11.8.	70.16.8.	5.5.	6.5.	7.4.
GNSS TOD – GSM time association	-	70.16.9.	-	-	-
Moving scenario and periodic update performance	-	-	5.6.	6.6.	7.5.

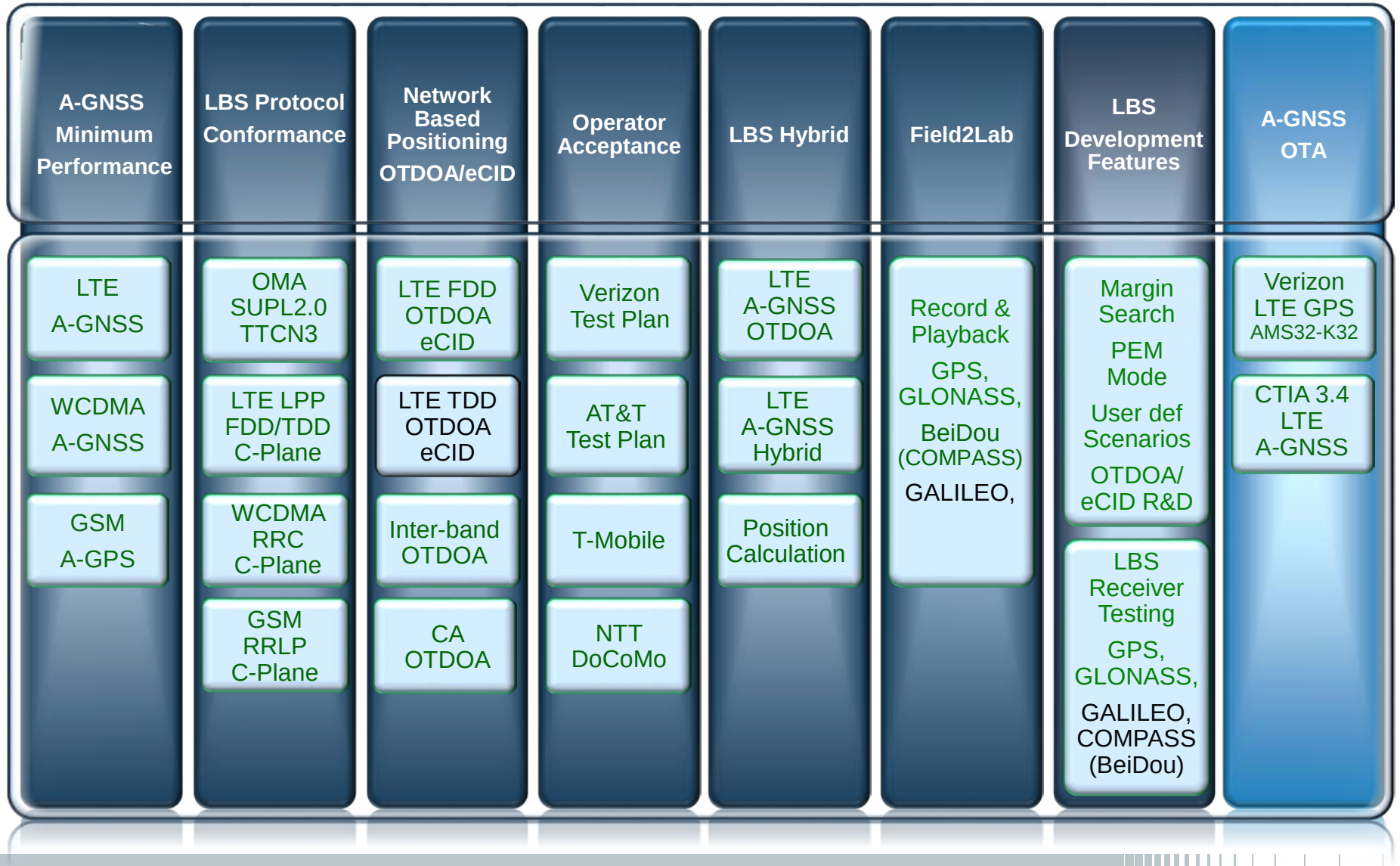
E-UTRA eCID	**TS 37.571-1 chapter 8**
E-UTRA OTDOA	**TS 37.571-1 chapter 9**

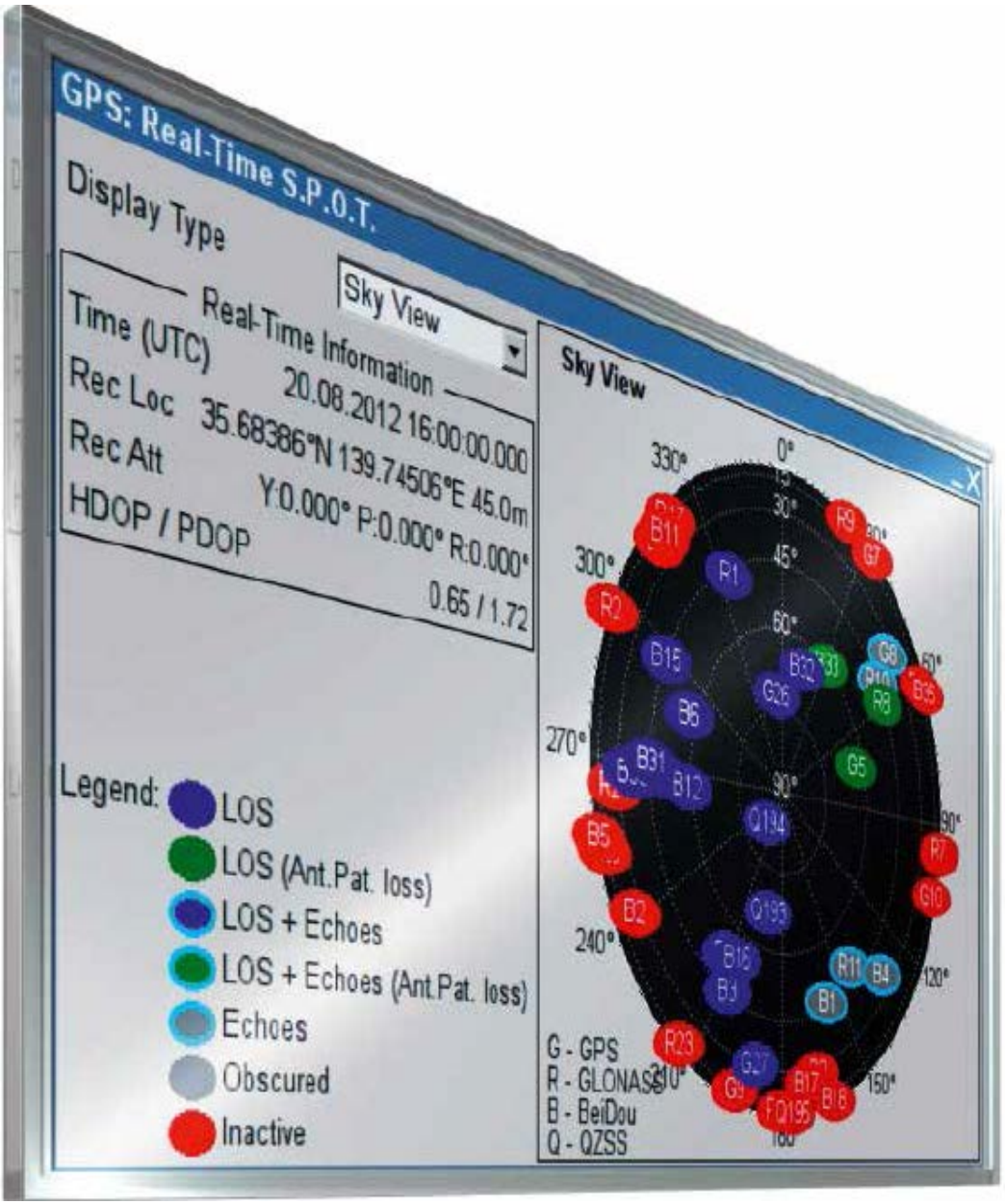
R&S的GNSS应用指南

下载： www.rohde-schwarz.com



TS-LBS 移动终端LBS测试系统总结





谢谢!

"If you want to go fast, go alone.
If you want to go far, go together!"

African proverb