



Kingdom of Bahrain GPS Permanent Reference Network

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Map Middle East 2007 - 11th April 2007



Topographic Survey Dir, TSD

National Mapping Agency, responsible for topographic surveying, mapping and geodetic control.

Development of Permanent GPS Network

Reasons

Communication

Products, RTK corrections

Issues/considerations

Successful

Additional tasks

Conclusion



جسر الملك فهد
Causeway

جزر أمواج
Amwaj

36km

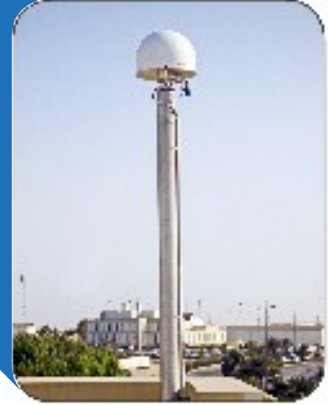
إدارة المسح الطبوغرافي
TSD



29km

43km

72km



مقر الكشافة
Scout

72km

44km



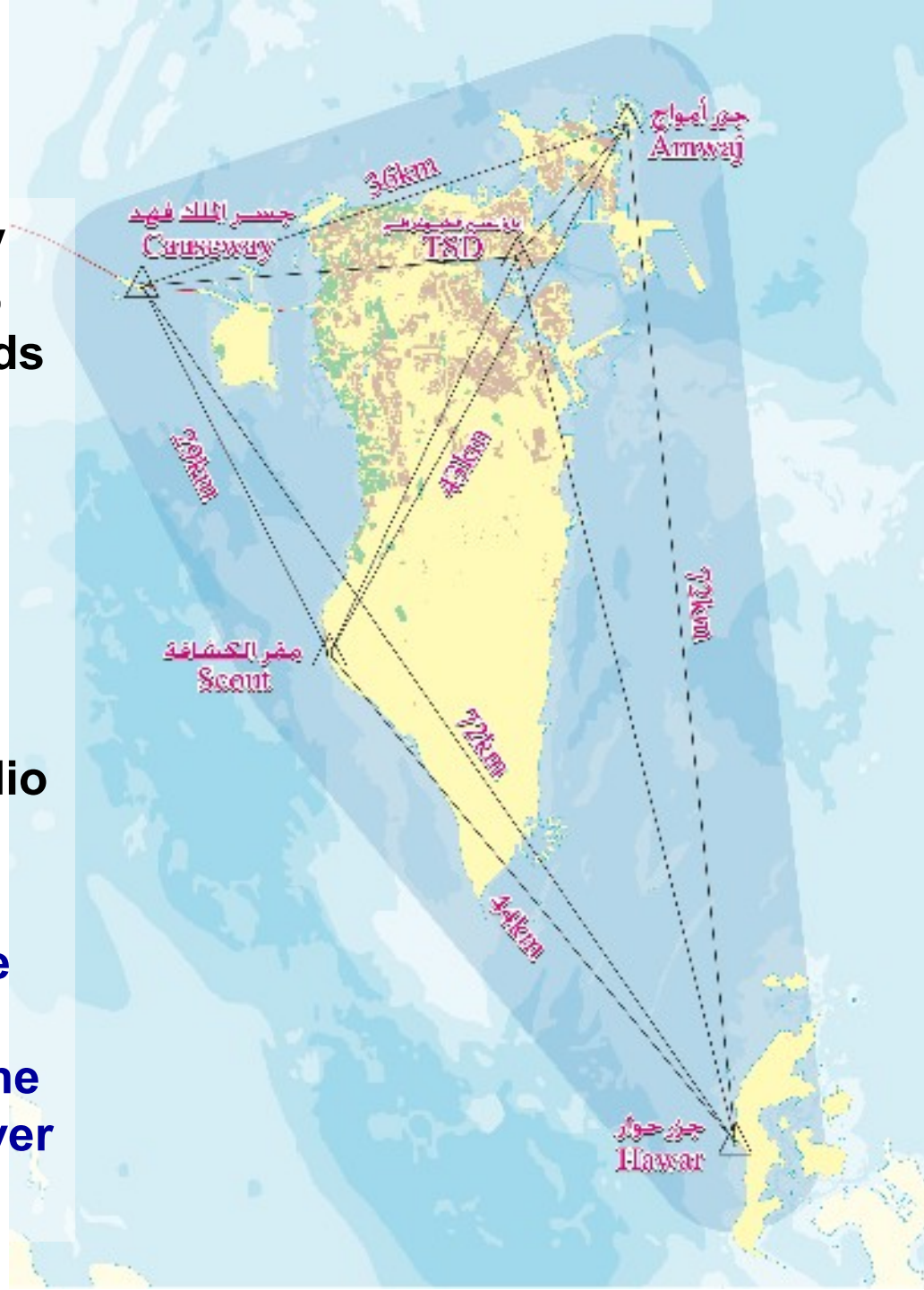
- Bahrain Land area 740km²
- Development in the north half
- 4 Reference Station covers 88%
- All four are hosted by external site owners
- Fifth station is an operating spare

جزر حوار
Hawar





- a buffer of only 5km covers 98% of all main islands of the country
- 8km buffer enables 100% coverage
- this requires mobile phone coverage (or radio broadcast to fill any gaps)
- plenty of scope for further reclamation in the northern area over next few years

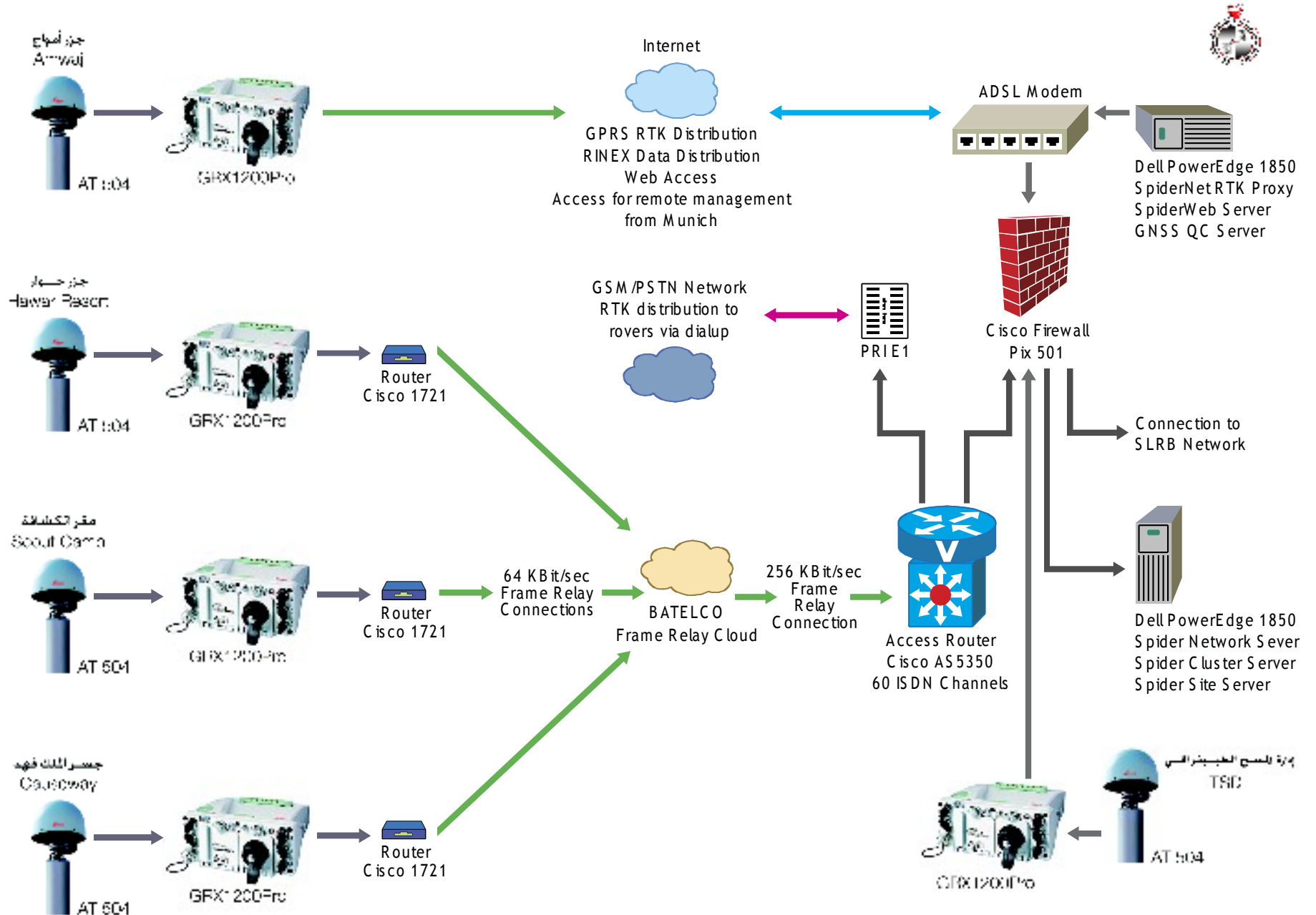




Reasons

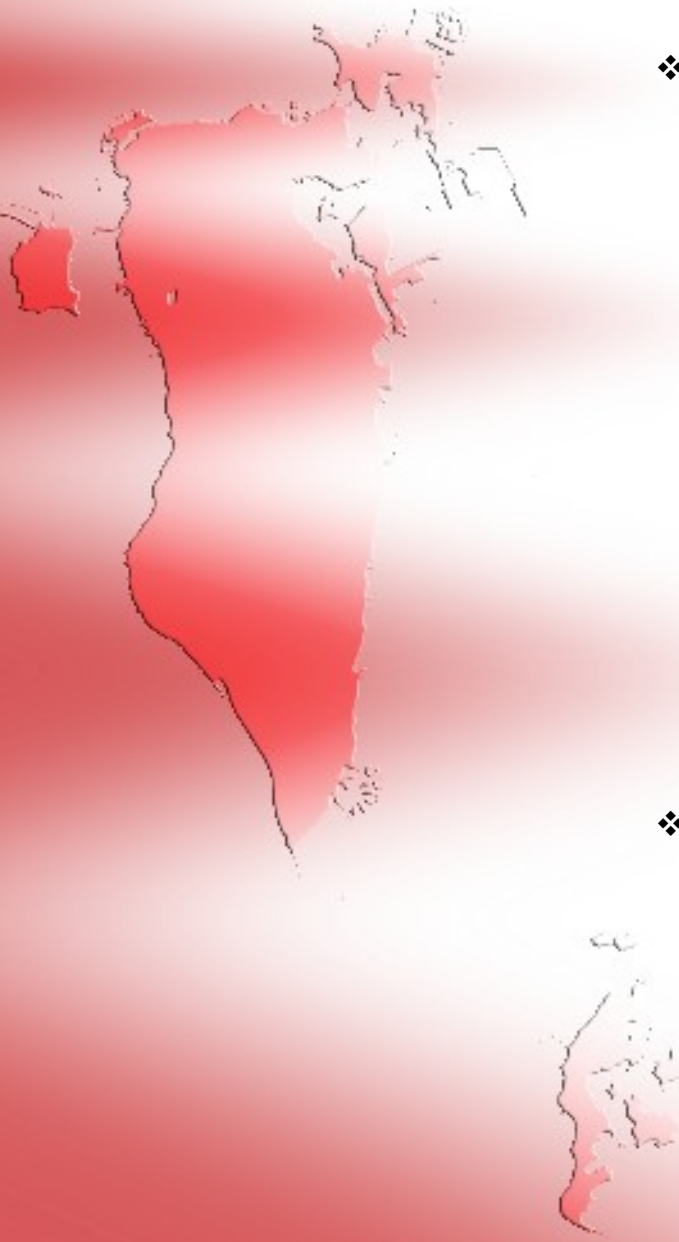
- ❖ Survey logistics of field crews – ease of use
- ❖ Cost to users << conventional RTK
- ❖ Consistent accuracy
- ❖ Maintenance of ground marks
- ❖ Greater control of operations

Communications



Products

- ❖ Real Time (covers all combinations of)
 - ❖ iMAX RTCM v2.3
 - ❖ Nearest site RTCM v3.0
 - ❖ NTRIP
 - ❖ Single Site
 - ❖ TCP/IP
 - ❖ Access router
- ❖ RINEX (at 1s and 30s for each site)
 - ❖ All sites 24h – 30s
 - ❖ All sites 1h – 1s
 - ❖ Each site 1h – 1s



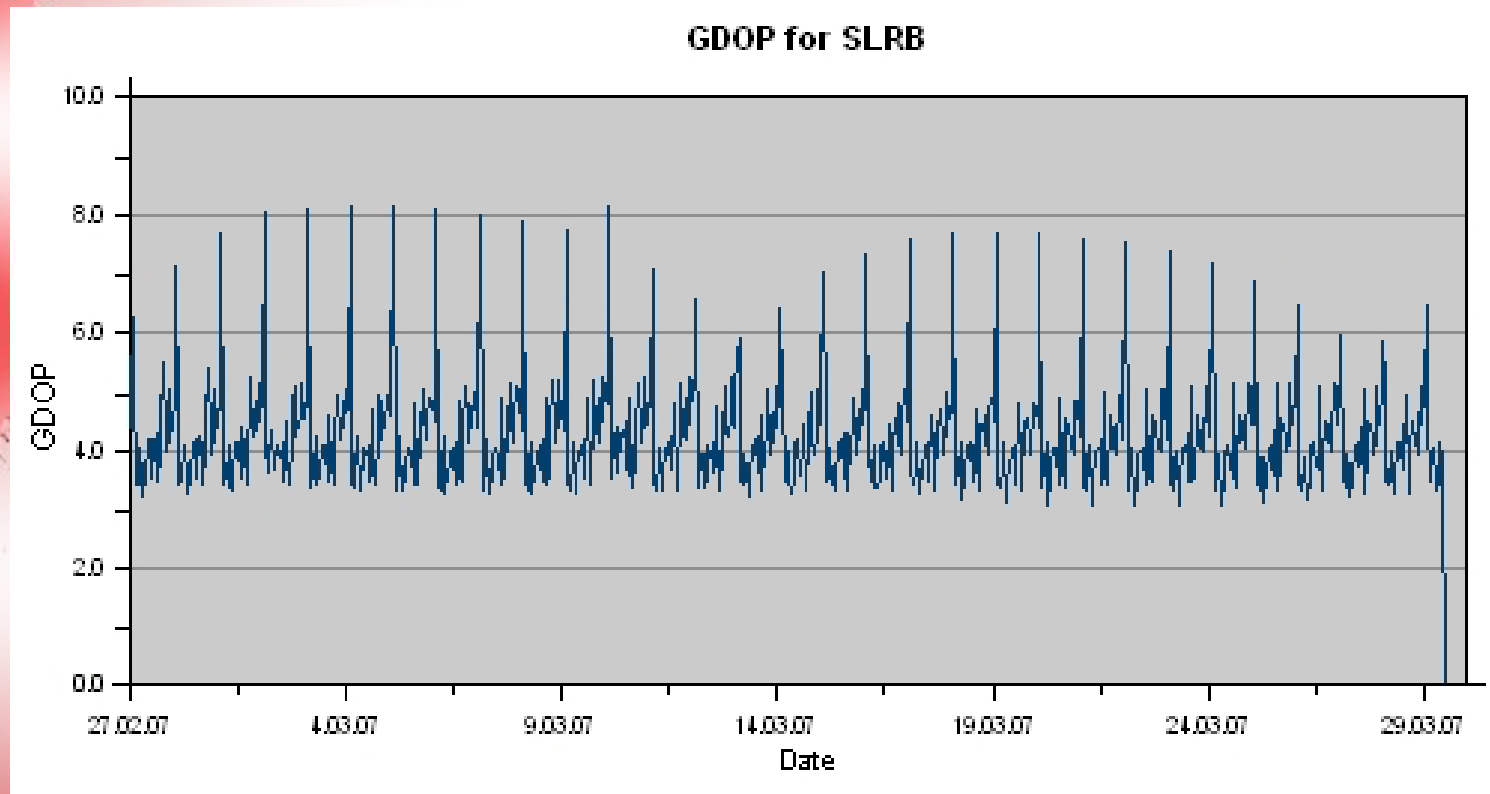


Issues/Considerations

- ❖ Site ownership and occupation
- ❖ Site investigation – data logging
- ❖ Proximity to utilities (power, telephone)
- ❖ Weather/climate
- ❖ Communication
- ❖ Accuracy
- ❖ Reliability
- ❖ Availability/access
- ❖ Equipment

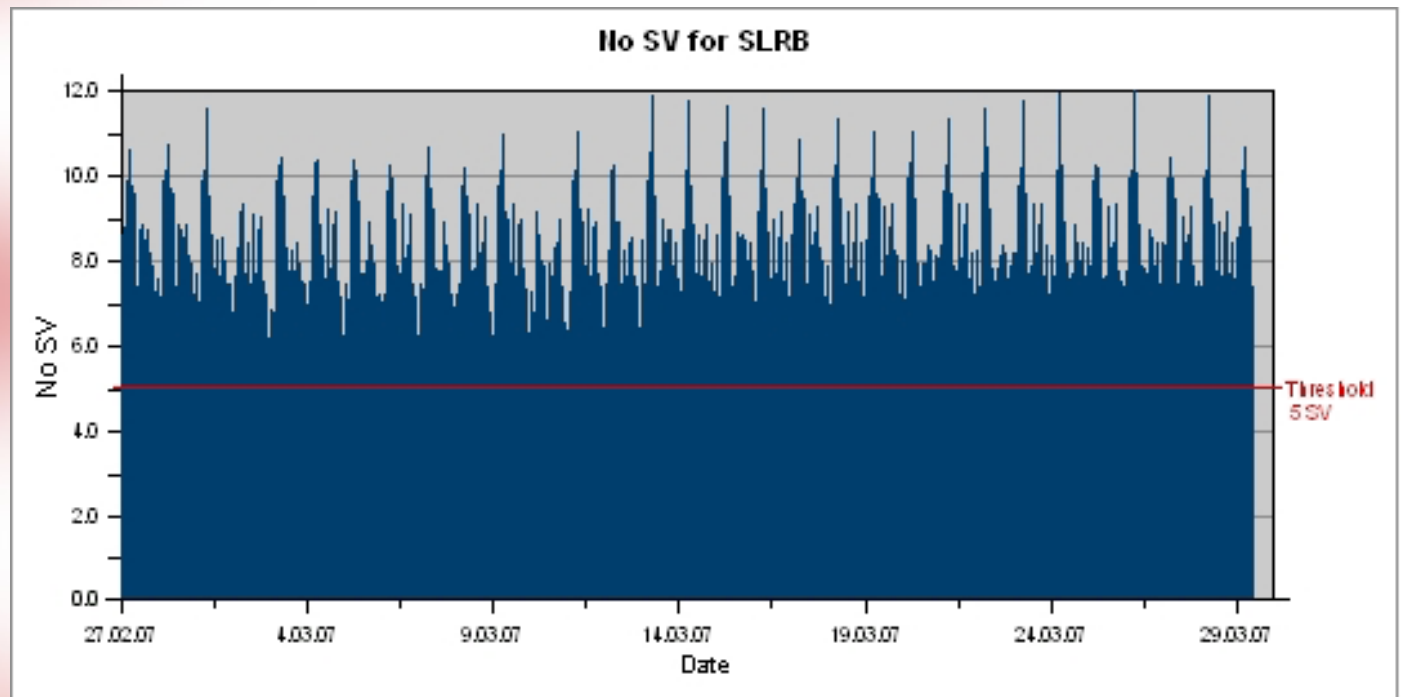
Successful

- ❖ Excellent GDOP – typically < 5



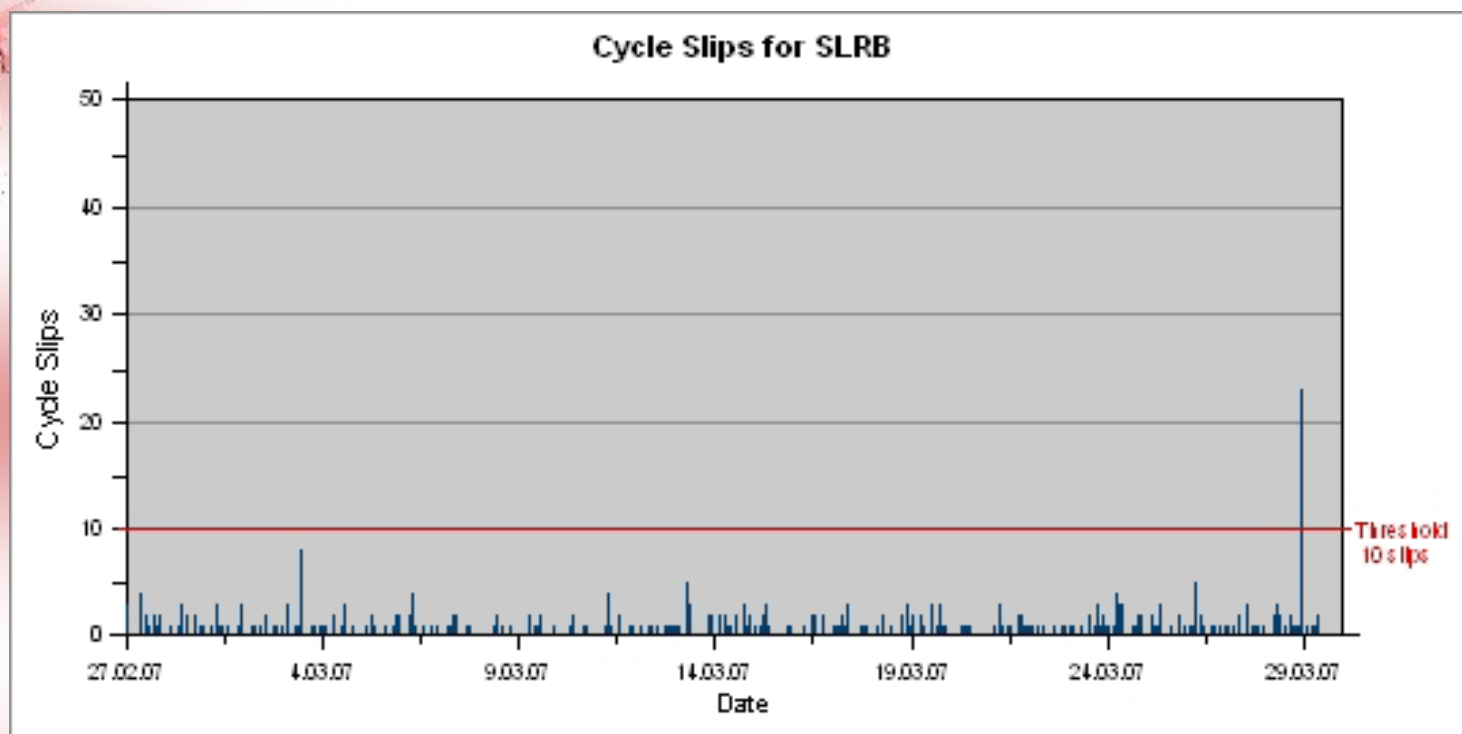
Successful

- ❖ Excellent tracking – typically ≥ 7 SVs



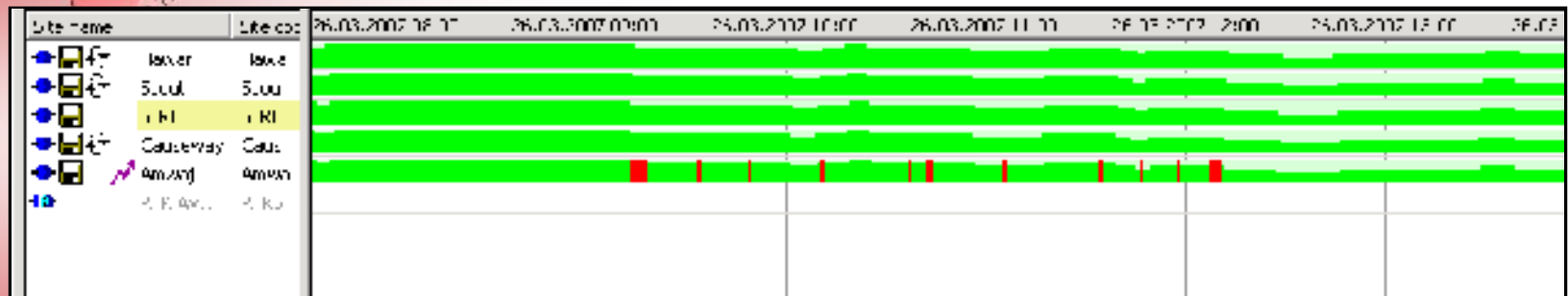
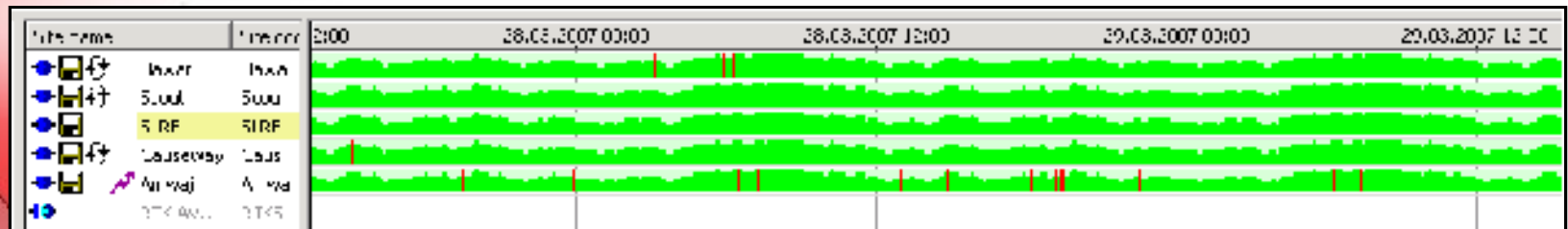
Successful

- ❖ Very low cycle slips – typically < 3



Successful

- ❖ Communication
 - ❖ High quality
 - ❖ Some outages – mostly on internet link





Additional tasks

- ❖ 3D transformation model – geometric relative geoid model – 2 to 3cm in position, 3-5cm for orthometric heights

450+ points	ΔE	ΔN	ΔH
Max	0.099	0.093	0.180
Min	0.000	0.000	0.000
Mean	0.021	0.000	0.022
SD	0.018	0.032	0.054



Additional tasks

- ❖ Software development to document long term system operation (short term is OK)
- ❖ QA measures – permanent rover – govt building and IT infrastructure
- ❖ Future expansion



Conclusion

- ❖ Very strong foundation for future surveying activities
- ❖ Other users especially private sector
- ❖ Other applications beyond surveying
- ❖ Opportunity to privatise operation in the future



<http://82.194.61.180/spiderweb/frmlIndex.aspx>

www.slr.gov.bh

Shukran