# Singapore Whitespace Pilot project

- Overview of the Pilots
- Link budget analysis of the golf club deployment
- M2M network in whitespace ?

video


Smart Radio, Smarter World

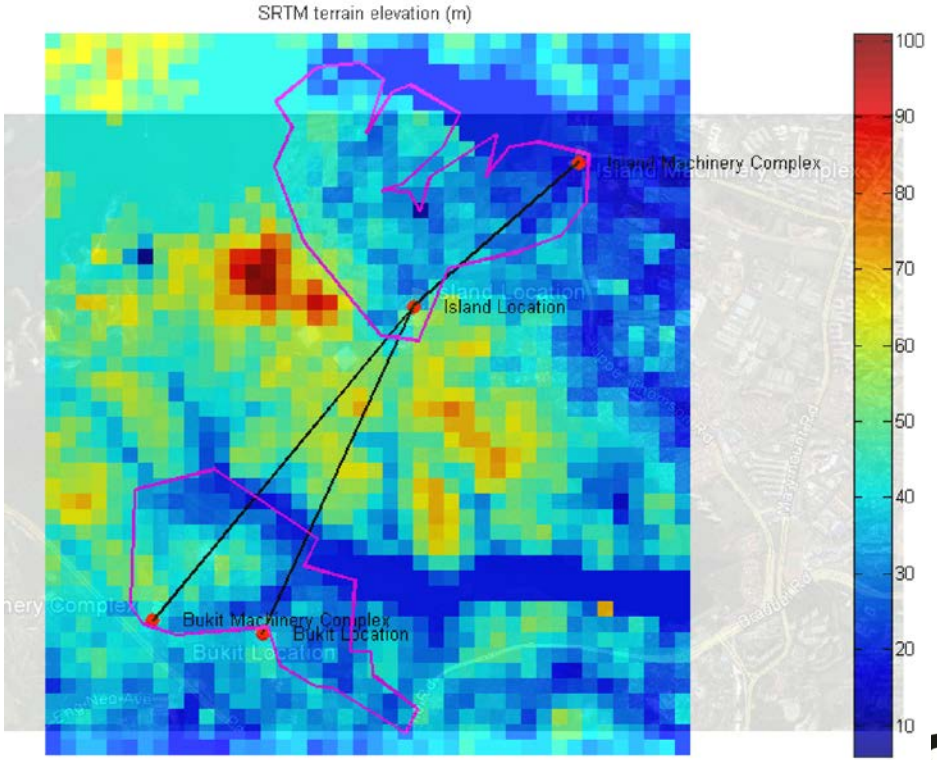
# The SICC golf broadband deployment


PARTNERS: SICC, Neul, Terrabit Networks and Microsoft

# Point to point links between four sites

# Propagation is dominated by terrain

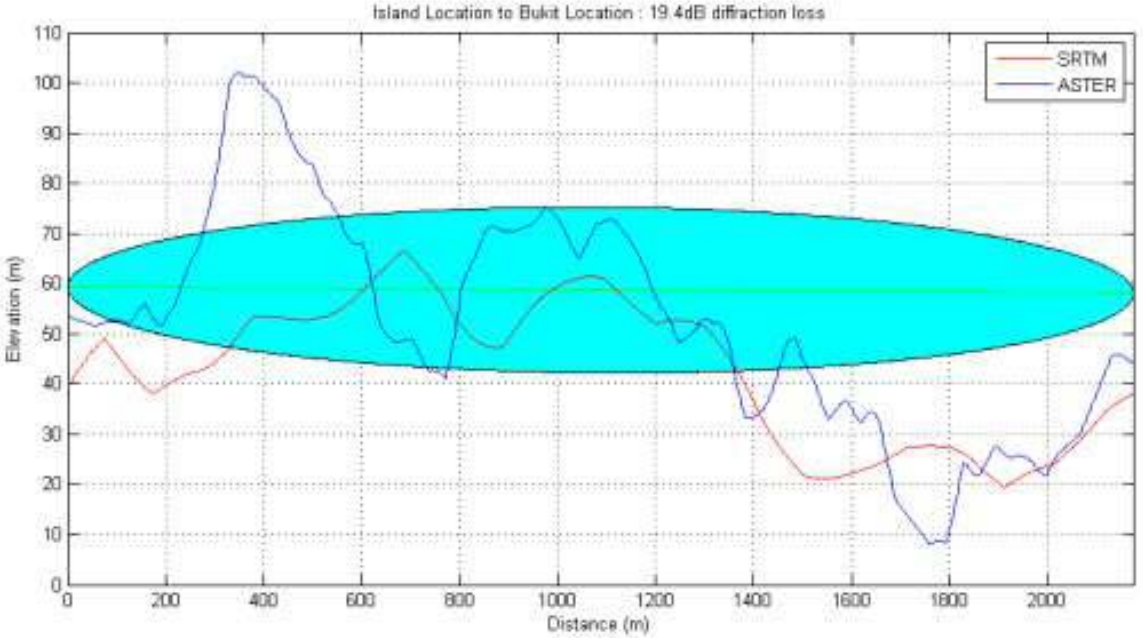
- Using terrain elevation from Shuttle Radar Topography Mission.
- Use extended Hata model
- Use terrain profile to estimate diffraction loss



# Profile example

- Assuming single knife edge
- Fresnel parameter ν = 1.99
- Diffraction loss = 19 dB

$$6.9+20\log(\sqrt{(\nu-0.1)^2+1}+\nu-0.1)$$



# Link budget

**PATH Loss**

| | Parameters | Contributions | Link budget |
|---|---|---|---|
| Path length | 2175m | | |
| Tx mast height | 20m | | |
| Rx mast | 20m | | |
| Frequency | 600MHz | | |
| Hata rural path loss | | 94.4 | |
| Fresnel parameter | 1.992 | | |
| Diffraction loss | | 19.4 dB | |
| Total path loss | | | 113.8 dB |

**Transmit parameters**

| | Parameters | Contributions | Link budget |
|---|---|---|---|
| Tx power | | 33 dBm | |
| Tx cable length | 30 | | |
| Tx cable atten | 5.5dB/100M | | |
| Tx cable loss | | 1.7 dB | |
| Tx antenna gain | | 2 dBi | |
| Tx EIRP | | | 33.3 dBm |

**Receive parameters**

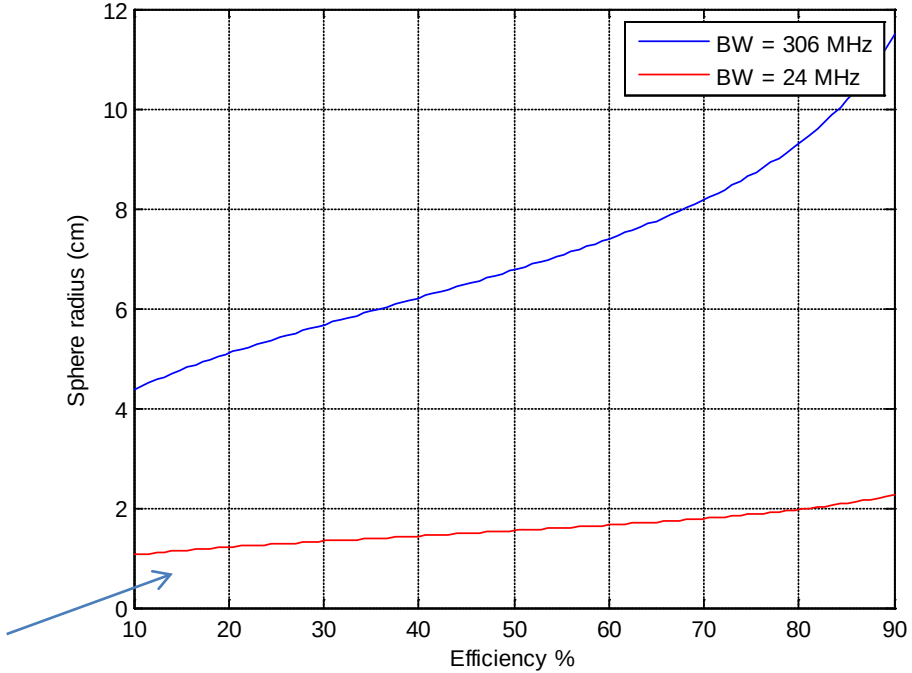
| | Parameters | Contributions | Link budget |
|---|---|---|---|
| Rx cable length | 30m | | |
| Rx cable attenuation | 5.5dB/100m | | |
| Rx cable loss | | 1.7 dB | |
| Rx antenna gain | | 2dBi | |
| Rx signal bandwidth | 5MHz | | |
| Rx thermal noise | -107 dBm | | |
| Rx noise figure | 6 dB | | |
| Rx effective noise | | -101.3 dBm | |
| Man made noise | | -95 dBm | |
| Rx sensitivity | | | -94.3 dBm |
| Received SNR | | | +13.8 dB |

64 QAM ½ rate coding requires 11dB
10Mbps/s PHY rate

# M2M deployment in Singapore TVWS ? Antenna size

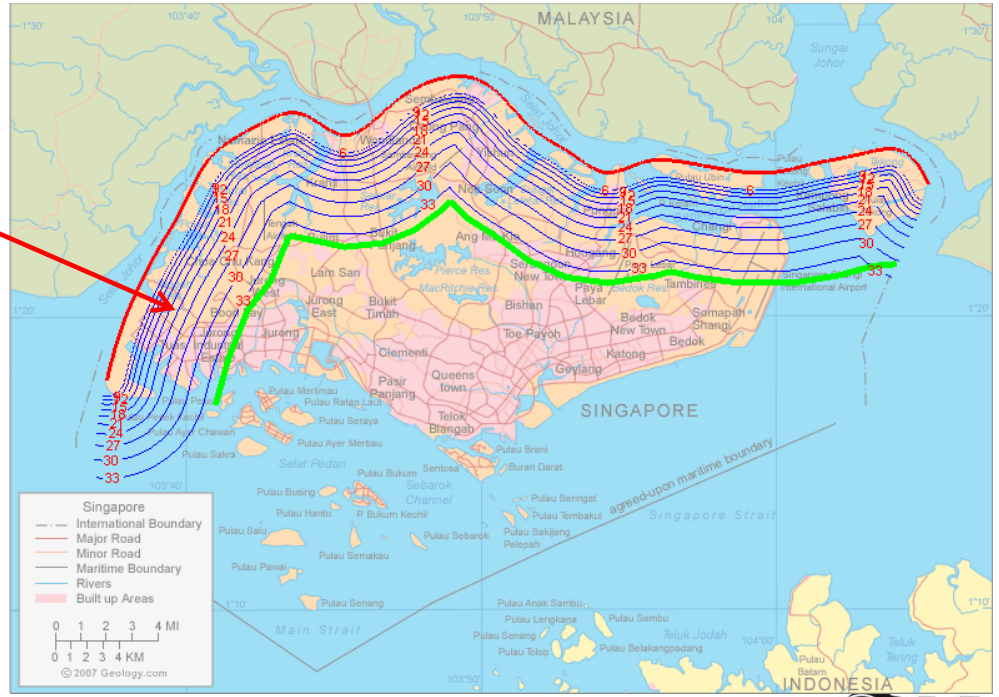
- Proposed TVWS frequencies cover from 502-806 MHz
- McLean sets the minimum antenna quality factor (Q) that can be achieved
- Q relates to antenna radiation efficiency

- Not possible to have efficient small antenna covering the whole TVWS band
- Requires to reduce total available bandwidth.
- Subdivide a single channel in multiple channels is viable



# TVWS Cellular M2M deployment border issue.

- Border interference requirements implies low power in the border region.
- Non geo-located devices will even be more affected.
- Very difficult to deploy a cellular infrastructure for indoor meter reading
- Viable for short range device type deployment



# Conclusions

- Outdoor Broadband deployments successful in TVWS
  - Good solution for remote backhaul

- Requirement for a viable M2M deployment in TVWS
  - Dedicate 1 channel for M2M application
    - Power spectral density limit not set proportionally to the bandwidth to allow splitting of 1 channel.
  - Border interference need to take into account potential location of TV receiver victims.