Satellite-based Cellular Backhaul

Application note

Version 0.2

July 2014

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Contents

1 Satellite-based Cellular Backhaul

Satellite-based cellular backhaul is used whenever the distance between cells is large, as in rural environments, and the alternative methods, such as microwave or fiber are impractical.

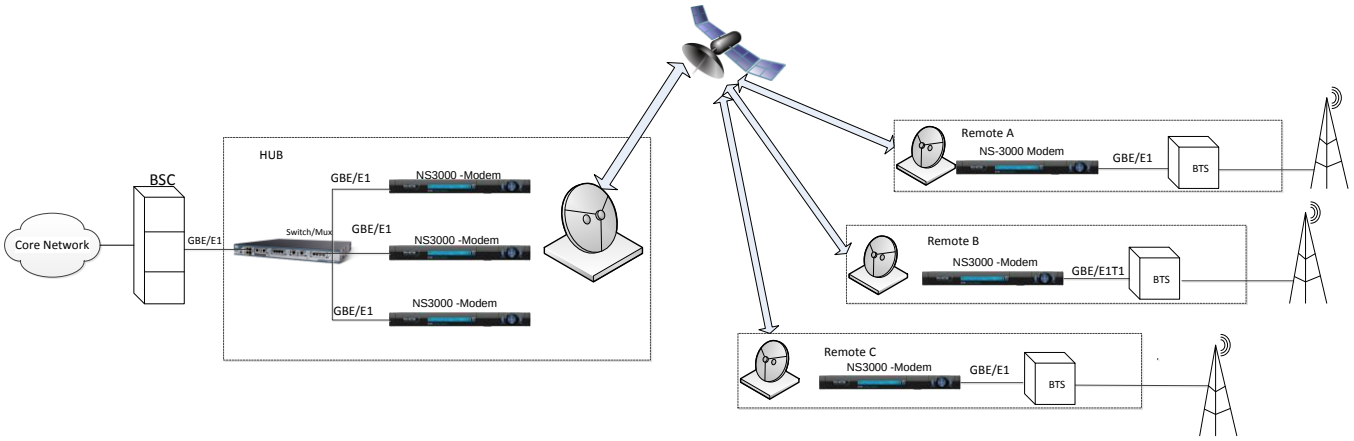
Due to an increase in broadband traffic and a decrease in total revenue per bit, there is a growing demand for providing efficient mobile networks in both high and low end markets. One of the key components is cellular backhaul, which connects the cellular Base Transceiver Stations (BTS) and the Base Station Controllers (BSC).

The most expensive part of satellite communication is the space bandwidth. So, maximizing the satellite capacity will have the most impact on OPEX.

NovelSat offers an attractive solution which can significantly reduce operating expenses on Satellite Cellular Backhaul.

NovelSat NS3000 modem advantages:

- High spectral efficiency:
  - **NovelSat NS3** - Can achieve 30%-60% better performance compared with DVB-S2
  - **NSPE** – Efficient IP encapsulation
- **NovelSat DUET** – Echo-Cancellation, utilizing the same bandwidth for both carriers. Can achieve more than 50% boost.
- Interfaces:
  - **E1/T1:** Up to four interfaces, Drop & Insert, Unframed/Framed-CRC4. Supported standards G.703, G.704 , G.823, G.824.
  - **GbE**: Jumbo Frames, QoS mechanism, L3 IP routing, L2 Bridging, CoS
- **OTA** – Over The Air control & monitoring of remote sites
- Lower link margin and high availability, under variable conditions:
  - **AUPC** – Automatic Uplink Power Control
  - **ACM** – Adaptive Coding & Modulation
- Immunity to interference (+15dB) – jamming, phase noise, etc.



NovelSat Satellite-based Cellular Backhaul

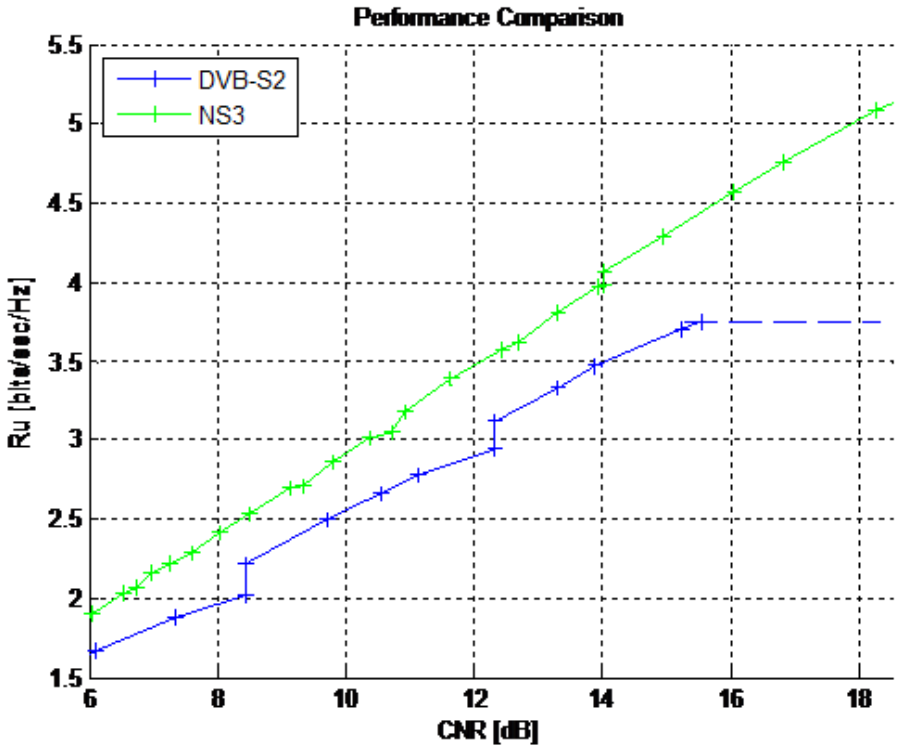
2 NovelSat NS3000 Modem Technologies

Following are several relevant technologies implemented in the NovelSat NS3000 modem.

2.1 NovelSat NS3

NovelSat NS3 advanced waveform has a high spectral efficiency. It typically boosts performance by 40%, and often by as much as 60% compared with DVB-S2 under identical conditions – same NovelSat bandwidth, noise level and power.

Below is the nominal performance graph. Please note that under any kind of interference, such as phase noise or non-linear effects, the NS3 capacity advantage increases significantly.

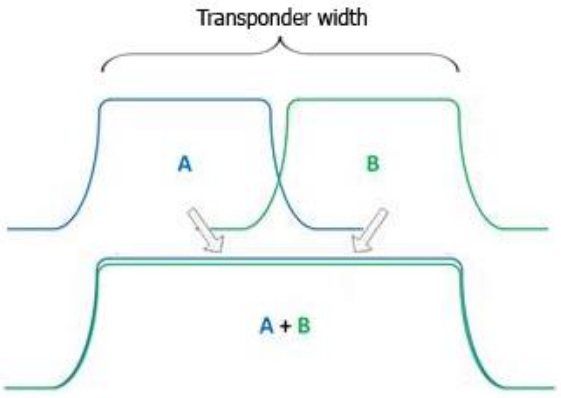


2.2 NovelSat DUET – Echo-Cancellation

NovelSat DUET utilizes the transponder as shown below:

NovelSat's unique algorithm & implementation provide the following advantages:

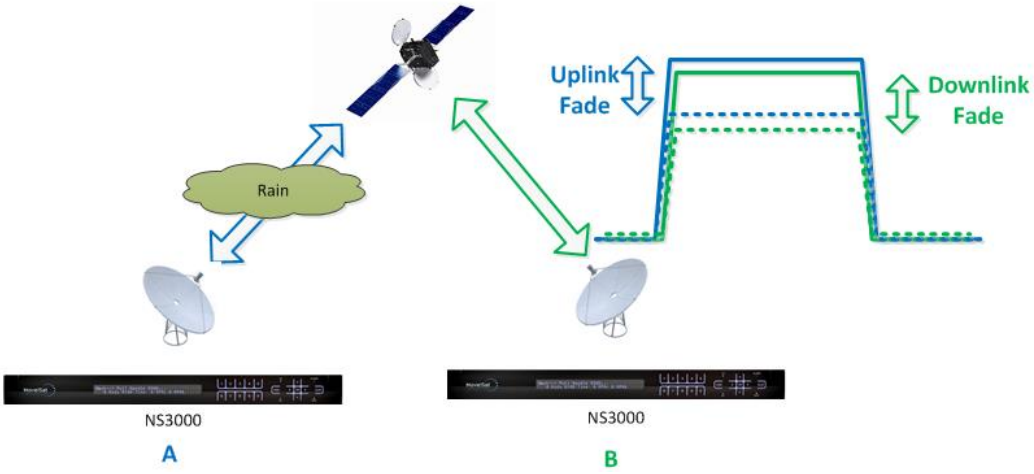
- Low implementation loss (<0.01dB)
- Built-in (no external HW – only license)
- No additional delay
- Large dynamic range (for asymmetric links)
- Carrier cancellation of 29dB
- Support Outbound/Inbound ratio of ± 10dB (as much as 16 dB in lab tests)



2.3 AUPC & ACM

2.3.1 AUPC – Automatic Uplink Power Control

The **AUPC** (Automatic Uplink Power Control) feature compensates for **uplink** fade by increasing uplink power, thus enabling reduction in link margin. It does not require a beacon receiver.

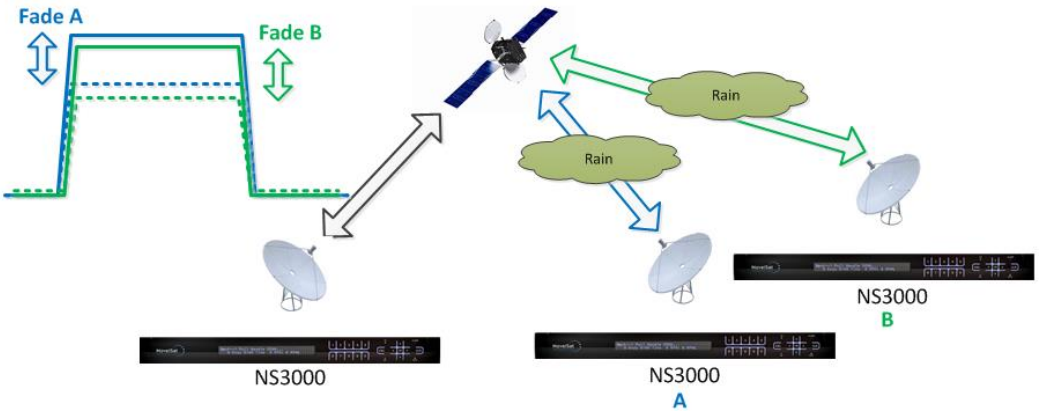


2.3.2 ACM – Adaptive Coding and Modulation

The **ACM** (Adaptive Coding and Modulation) feature compensates for **downlink** attenuation by estimating the channel at the remote and changing the MODCOD.

Advanced Channel Estimation for Each Remote:

- Non-Linear Channel
- Phase noise
- Other impairments



3 Case Study

Following is an example, based on an actual implementation, of the NovelSat Cellular Backhaul solution.

Using the NovelSat NS3000 modem, the user achieved ~**200% improvement** in bandwidth utilization.

The standard implementation achieved **18 x E1 links** per 36MHz transponder, while the NovelSat solution achieved **57 x E1 links** on a **single 36MHz** transponder.

3.1 Details

Satellite communication network:

- Interface to BSC/BTS : Framed **E1** (Unframed is 2.048 Mbps per E1)
- Antenna size : Hub: 9m, Remote: 3.8m
- Satellite : 36MHz transponder, 40 dBW EIRP
- C-Band
- Link Margin: normally 3dB, with AUPC 1dB

Data rate is symmetrical, but the antenna sizes are different: Use the same bandwidth and MODCOD but at different power level.

Since the data rate is constant, use AUPC without ACM, 1dB Link margin.

- CNR:
  - Remote – Initial Maximal CNR = 13.8dB , Actual CNR (with DUET) = 13.1dB
  - Hub – Initial Maximal CNR = 21.4dB , Actual CNR(with DUET) = 12.9dB
- Requested Margin > 1dB
- Occupied Bandwidth = 0.63MHz
- Data-rate > 2.048Mbps
- Waveform:
  - Protocol: NS3
  - Modulation: 32APSK
  - FEC Rate: 32/45
  - Spectral Eff.: 3.27 Bit/Hz/sec
- EIRP Gain difference: Hub -8.53dB, Remote -0.66dB

4 About NovelSat

NovelSat is a technology company dedicated to providing the next-generation modulation standard for satellite communications. NovelSat NS3™ technology – encompassing ultra-high end modulators, demodulators, modems and ASICs – essentially replaces DVB-S2 as the industry standard. NovelSat delivers the fastest data rates, the widest pipe and the most compelling ROI. That means you get the best performance at the lowest costs, resulting in the highest profits.

4.1 Contact Information

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