

Improving the VoIP Capacity in WiMAX Networks

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Outline

The topics to be presented:

- Existent 802.16 ns-2 modules
- WINSE features
- Research topics studied with WINSE
- New VoIP enhancements in WiMAX

Project Members

- University of Jyväskylä/ Telecommunication laboratory

Timo Hämäläinen, professor, project manager

Olli Alanen, PhD, (Magister Solutions), ext. consultant

Henrik Martikainen (PhDs), MAC

Vitaliy Tykhomyrov (PhDs), scheduler

Oleksandr Puchko (PhDs), PHY

Vesa Hytönen (Mscs), simulations

- Nokia & NSN

Alexander Sayenko (PhD), (project manager)

Senior Research Engineer

Existent 802.16 NS-2 Modules

- NIST module
- NDSL module
- WiMAX Forum module
- Pisa university Mesh module
- 802.16 extension for NS-2 from the Eurecom Institute
- Module from KAIST university

WINSE Features

PHY Level

- General framework to introduce easily PHY layers
- OFDM PHY & OFDMA PHY
- Trace based PHY model and other propagation models
- Error generation model based on SNR and BLER waterfall curves
- Channel reports
- Link adaptation model
- BLER curves
- Repetition factors
- HARQ mechanism (only Type I(CC) is implemented)

WINSE Features

MAC Level

- ARQ mechanism
- Queue system
- Contention resolution
- MAC PDUs
- Prioritization of the ARQ feedbacks and retransmissions
- Packing and fragmentation
- Contention and ranging periods
- MAC level management messages
- ARQ implementation (all ARQ feedback types)
 - ARQ blocks
 - ARQ transmission window
 - Retransmission with rearrangement
- Downlink and uplink transmission

Research Topics Studied With WINSE⁷

1. Scheduling & resource allocation
2. Uplink contention performance
3. AQM
4. Optimal PDU Size
5. ARQ
6. ARQ & HARQ performance
7. Link Adaptation, CQICH
8. TDD, FDD, H-FDD
9. Relays
10. Sub-MAPs



Ongoing Research Topics

1. VoIP capacity
2. Persistent scheduling
3. 802.16j: scheduling, ARQ, HARQ
4. 802.16m

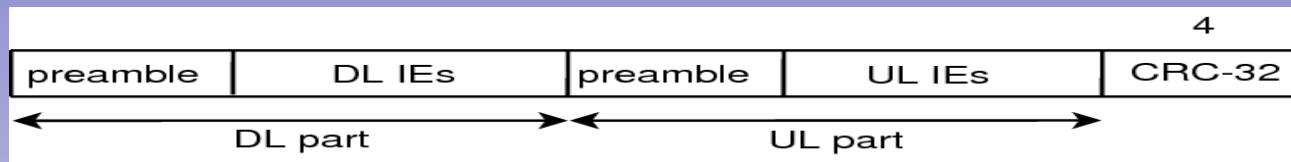
VoIP Capacity in WiMAX Networks

- One of the focus areas for IEEE 802.16e is the expansion of VoIP capacity
- Overhead is important for VoIP applications due to the frequent transmission and small packet size
- To decrease the MAP overhead, the 802.16 standard proposes a few mechanisms, such as the compressed MAP and sub-MAPs
- Sub-MAPs in VoIP applications can increase the system capacity by almost 100%

Different Map Types

Compressed Map

- It integrates DL-MAP and UL-MAP into a single message and saves space by removing fields
- If it is dropped, then both the DL-MAP and UL-MAP entries are lost
- Should be transmitted with quite a robust MCS to ensure that all the stations receive it correctly
- There is a common CRC field, but no GMH and Type fields(see figure)



DL-MAP: 13 bytes

UL-MAP: 8 bytes

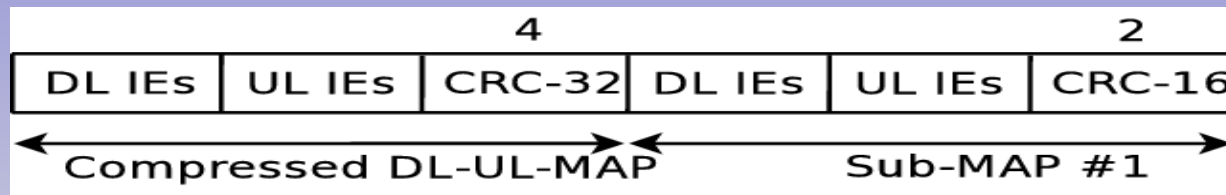
Compressed MAP: 11 bytes

Sub-MAP: 9 bytes

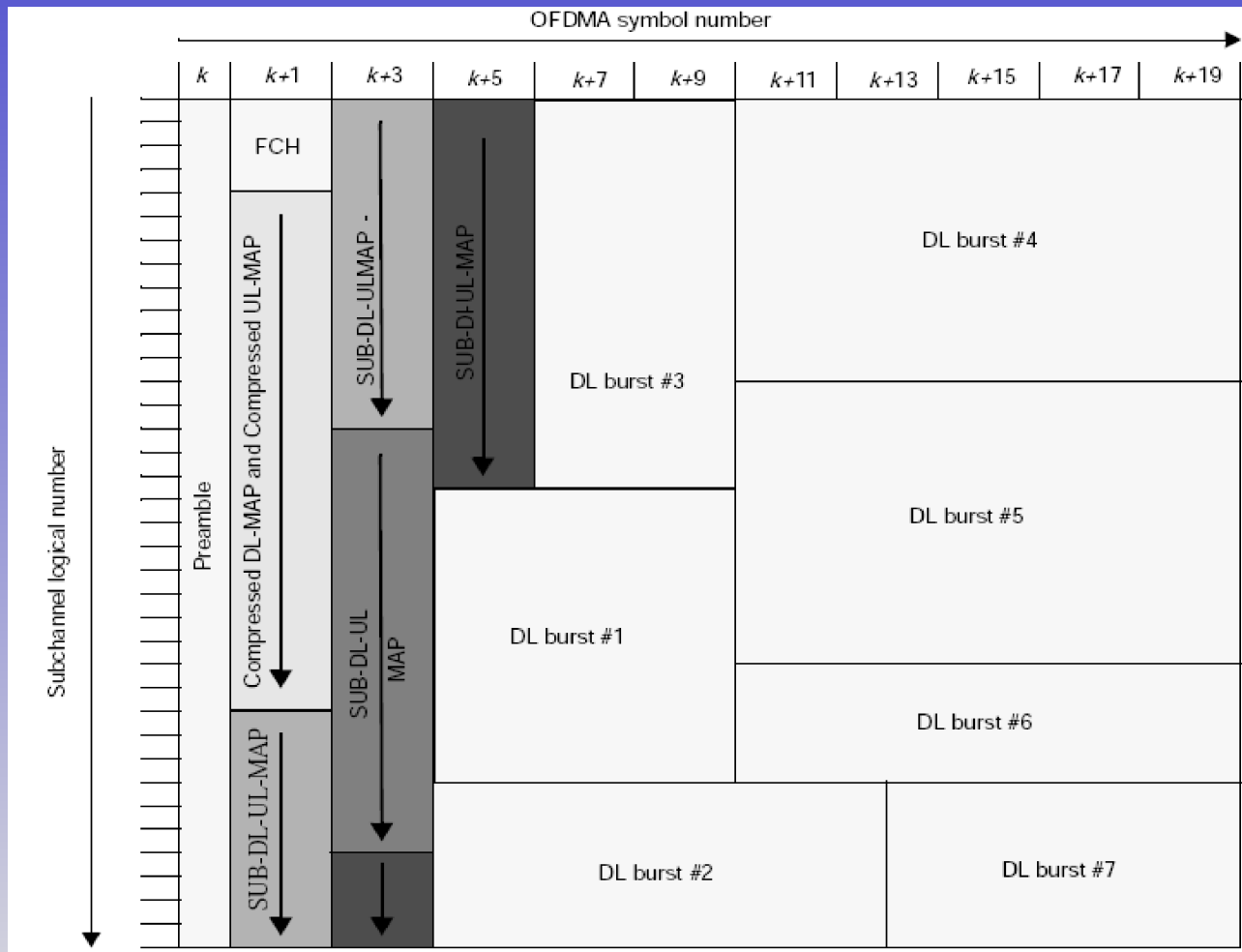
Different Map Types

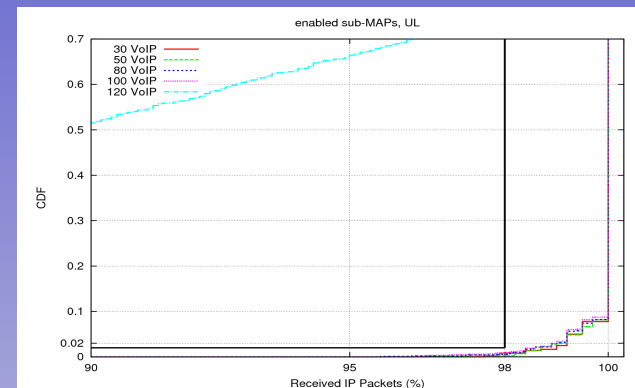
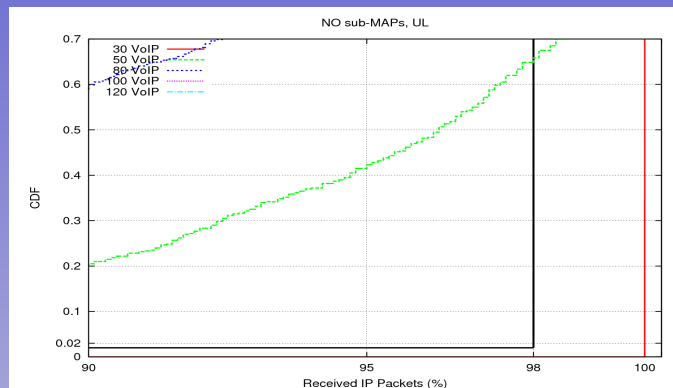
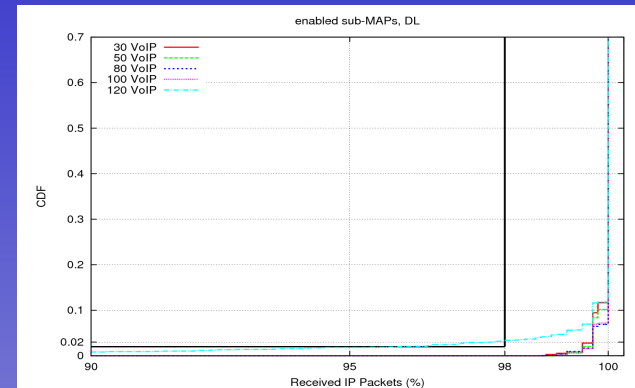
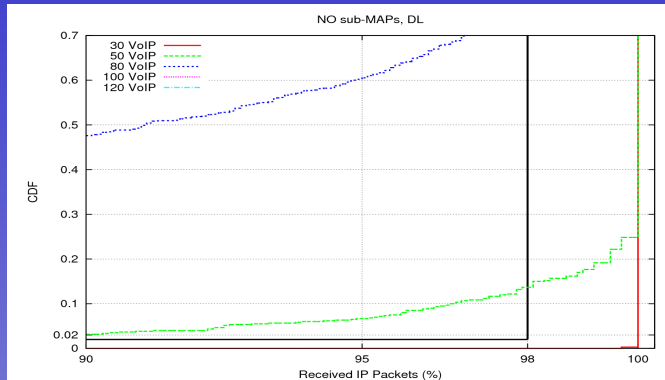
Sub-Map

- The 802.16 standard introduced sub-MAPs that allow for splitting a MAP message into a number of independent messages, each of which is encoded with a more efficient MCS
- The sub-MAP format is quite similar to the compressed MAP with a few additional enhancements, such as CRC-16 field instead of CRC-32
- The 802.16 specification just defines the maximum number of **3** sub-MAPs that can appear in a frame. The exact number, configuration, and MCS to encode a particular sub-MAP are left undefined.



The Placement of Sub-MAPs Within a Frame





DL, disabled sub-MAPs: max. number of SS is 30

DL, enabled sub-MAPs: max. number of SS is ~120

UL, disabled sub-MAPs: max. number of SS is 30

UL, enabled sub-MAPs: max. number of SS is ~100

Conclusions

- sub-MAPs in VoIP applications can increase the system capacity by almost 100%
- Existent NS-2 framework is reused.
- Highly modular architecture.
- The PHY and MAC implementation have all the major features.