Improving the VoIP Capacity in WiMAX Networks

Vitaliy Tykhomyrov

Telecommunication laboratory
MIT department
University of Jyväskylä

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 WINSE

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

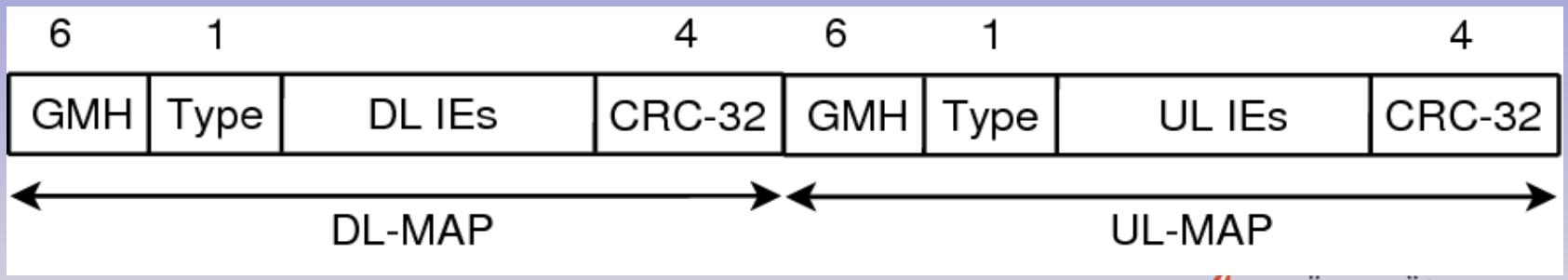
1. VoIP capacity
2. Persistent scheduling
3. 802.16j: scheduling, ARQ, HARQ
4. 802.16m

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%

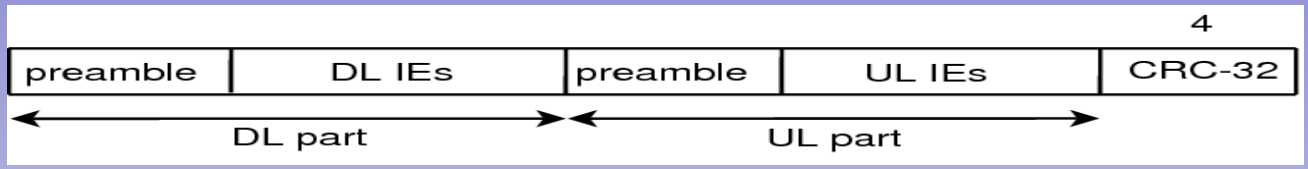
Different Map Types
Normal Map

- Two MAP messages – DL and UL allocations
- Each of them contains information on allocations scheduled for the DL and UL direction, respectively
- The MAP message is the most frequently constructed broadcast message and should be included in every frame
- Should be transmitted reliably using quite robust modulation and coding scheme (MCS) to ensure that all the stations receive them correctly
- As a result of using robust MCSs, the control overhead increases



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

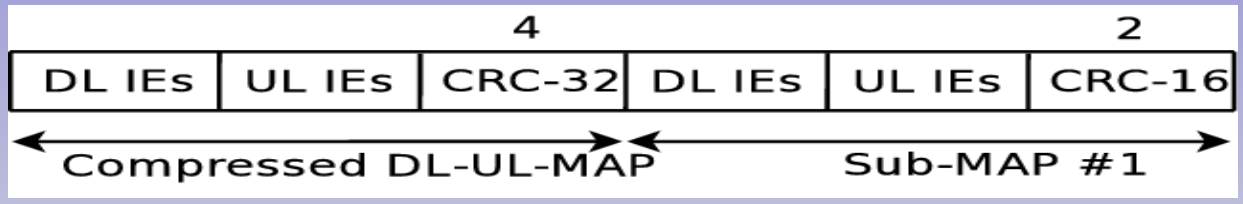
UL-MAP: 8 bytes

Compressed MAP: 11 bytes

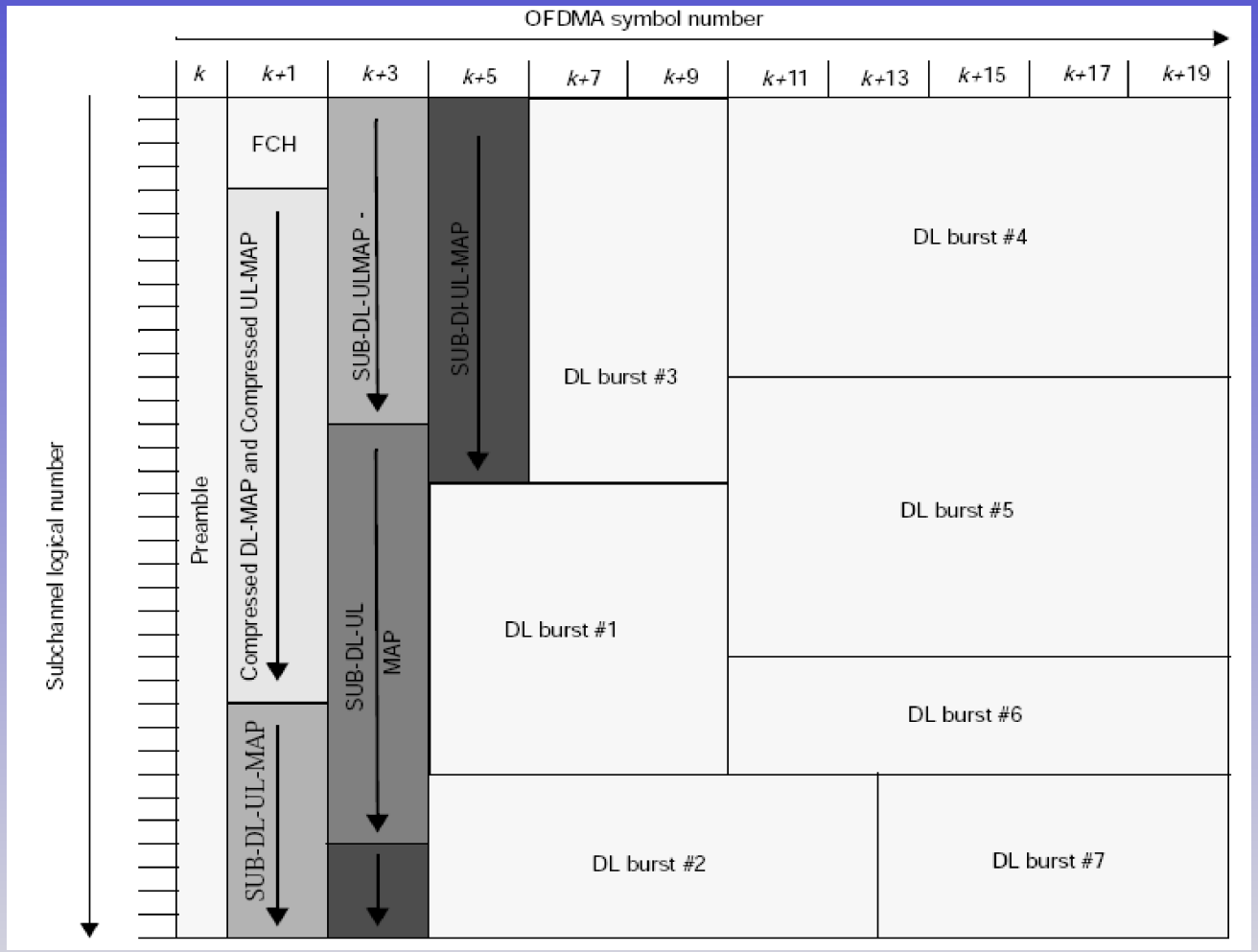
Sub-MAP: 9 bytes

Different Map Types
Sub-Map

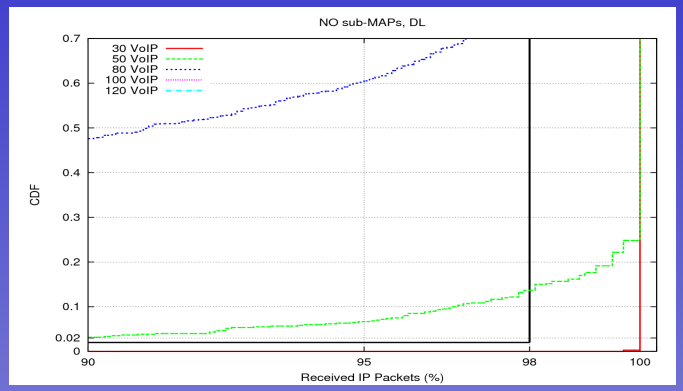
- The 802.16 standard introduced sub-MAPs that allow for splitting a MAP message into a number of independent messages, each of which is encoded with a more efficient MCS
- The sub-MAP format is quite similar to the compressed MAP with a few additional enhancements, such as CRC-16 field instead of CRC-32
- 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.

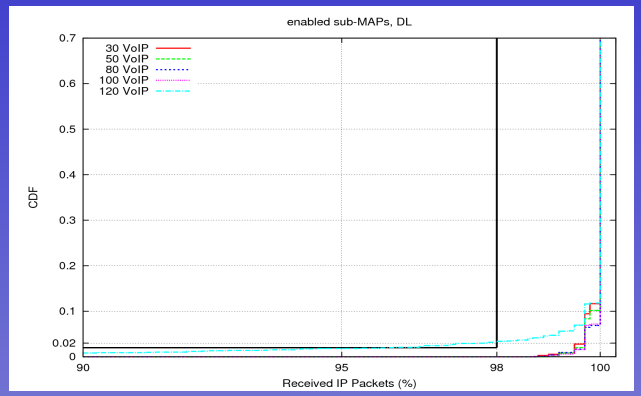


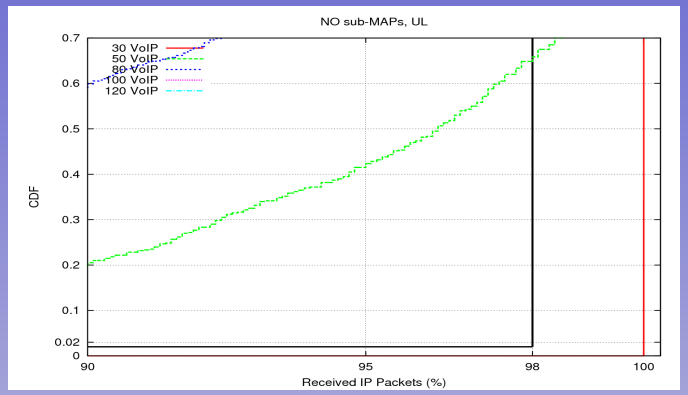
The Placement of Sub-MAPs Within a Frame

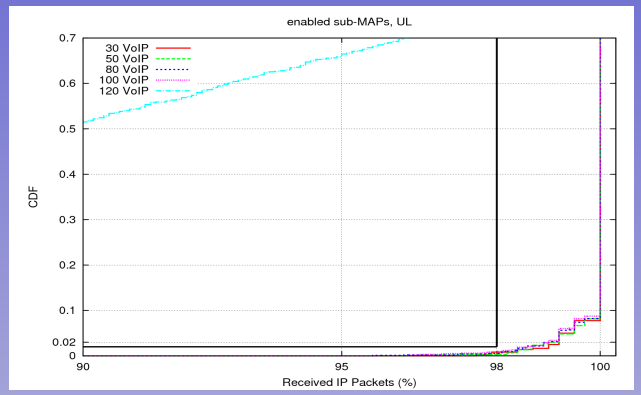


Results









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.