
HIGH DATA RATE TECHNOLOGY FOR HF COMMUNICATIONS (HDR-HF)

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OVERVIEW

- Motivation and goals of the HDR-HF project
- System architecture of the demonstrator prototype
 - Multimedia subsystem
 - IP-Gateway subsystem
 - Modem subsystem
 - Radio subsystem
- Performance evaluation
 - Real HF link
 - Wired HF lab setup
- Future work

Project context

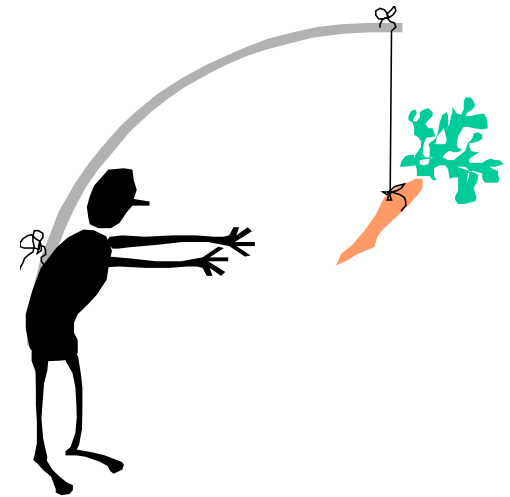
- Research project within EDA ad-hoc B program
- Partially funded by FR, BE & GER MoDs
- Timeframe: April 2009 – February 2012

THALES



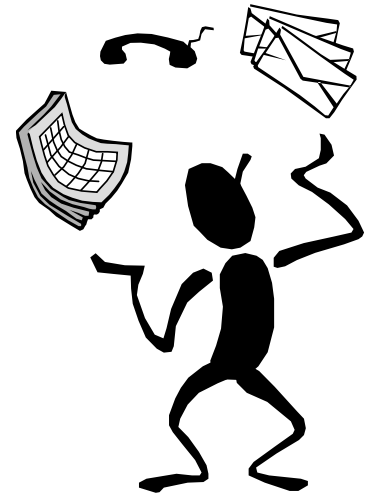
Project motivations

- High data rates over HF links with IP-based data transmission
 - Multimedia, voice and image applications
 - Need for higher data rates ≥ 64 kbps
- Development and demonstration of an end-to-end IPv6-capable very high data rate HF-system
 - Data & multimedia applications
 - IPv6 gateway and proxy
 - Wideband HF waveform
 - Wideband radio front-end
- Validation of the demonstrator prototype
 - On-air trials and lab measurements

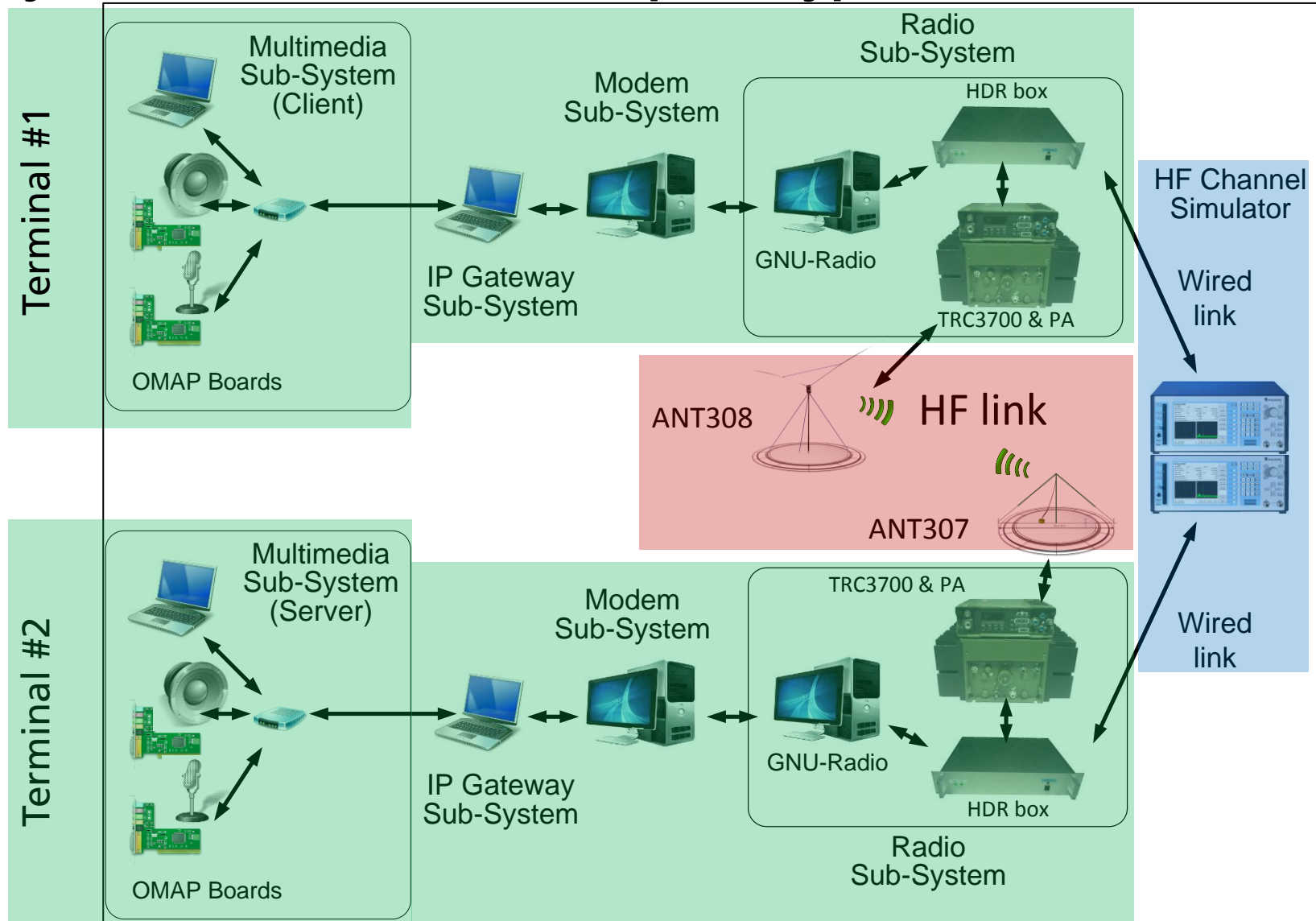


Project challenges

- Specific constraints on the HF link
 - Error-prone HF channel (data applications need errorless transmission)
 - Satisfy the latency requirements for e.g. FTP, email, web browsing
- IP over HF raises issues
 - Many IP applications rely on TCP, which is not adapted to channels with large delays
 - Overhead due to IP headers



System architecture of the prototype demonstrator



Multimedia sub-system: Key features

- Improved quality for voice (messaging and real-time)
 - Wideband MELP vocoder
 - Implemented on a real-time platform
- Robust transmission of images
 - Progressive/interactive image transmission using JPEG2000 interactive Protocol

IP-Gateway sub-system: Key features

- IP-native implementation (IPv6)
- Optimizations for transparent and effective use of Multimedia/data IP applications over HF links
- Performance Enhancing Proxy (PEP) for TCP/IP applications
- Robust Header Compression (RoHC)
- Joint QoS scheduling & retransmissions management

Modem sub-system: Key features

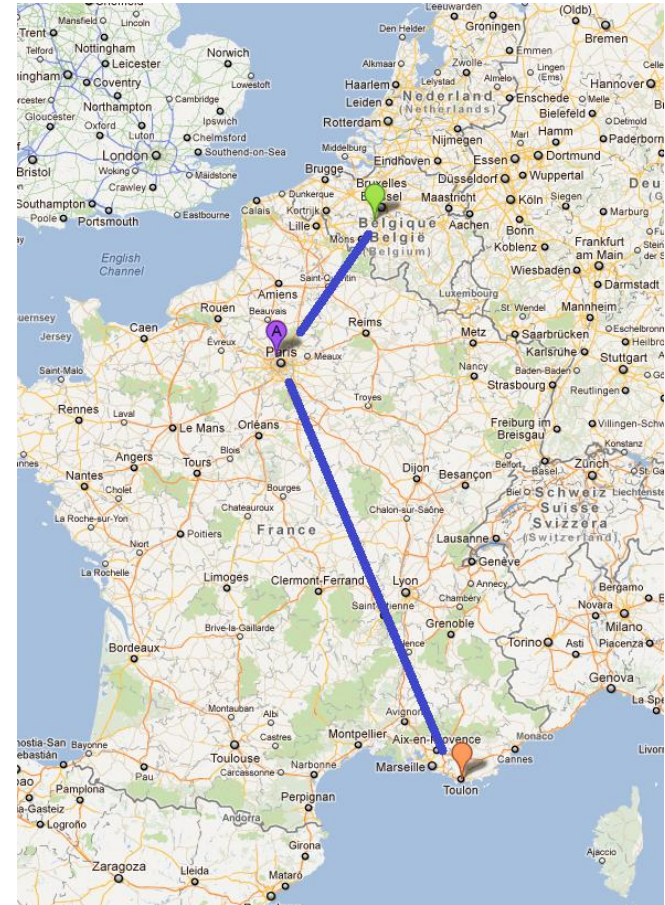
- Robust OFDM waveform
- Scalable bandwidth 3 kHz - 24 kHz
- QAM-4 to QAM-256 modulation
- Variable interleaver length (80 ms - 8 s)
- Turbo-coding FEC with fixed CR 1/2 (voice transmission)
- Hybrid-ARQ-module with Turbo-coding, CR 5/6 - 1/3 (data transmission)

Radio sub-system: Key features

- Wideband HF radio transceiver
- $F=1.5$ to 30 MHz
- Scalable bandwidth 3 kHz - 24 kHz
- SDR implementation of the HF radio functions
- Reuse and adaptation of existing components, e.g. USRP

Performance evaluation on real HF link

- Goal:
 - Validate feasibility of demonstrator
- Realization of measurement campaigns
 - Colombes (FR) \leftrightarrow Toulon (FR)
 - Colombes (FR) \leftrightarrow Tubize (BE)
 - Stationary transmission
 - 400 Watts Power Amplifiers
 - 6 kHz & 12 kHz bandwidth
- Result:
 - "all-IP" traffic was proven on real HF link!



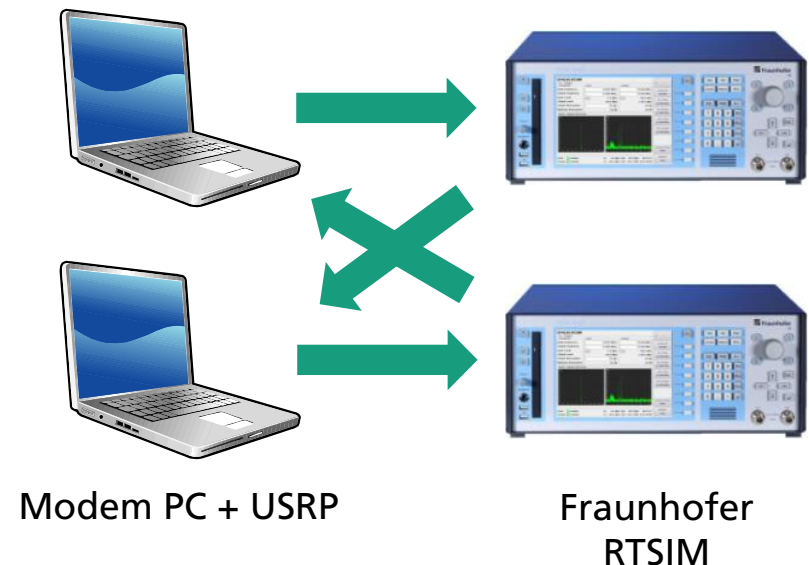
Performance evaluation on wired HF lab setup

■ Goal:

- Evaluation of the waveform performance

■ Laboratory setup:

- Waveform running on PC
- Ettus USRP hardware enables HF transmission
- Fraunhofer real-time HF channel simulator (RTSIM)
- 24 kHz bandwidth
- Bi-directional transmission



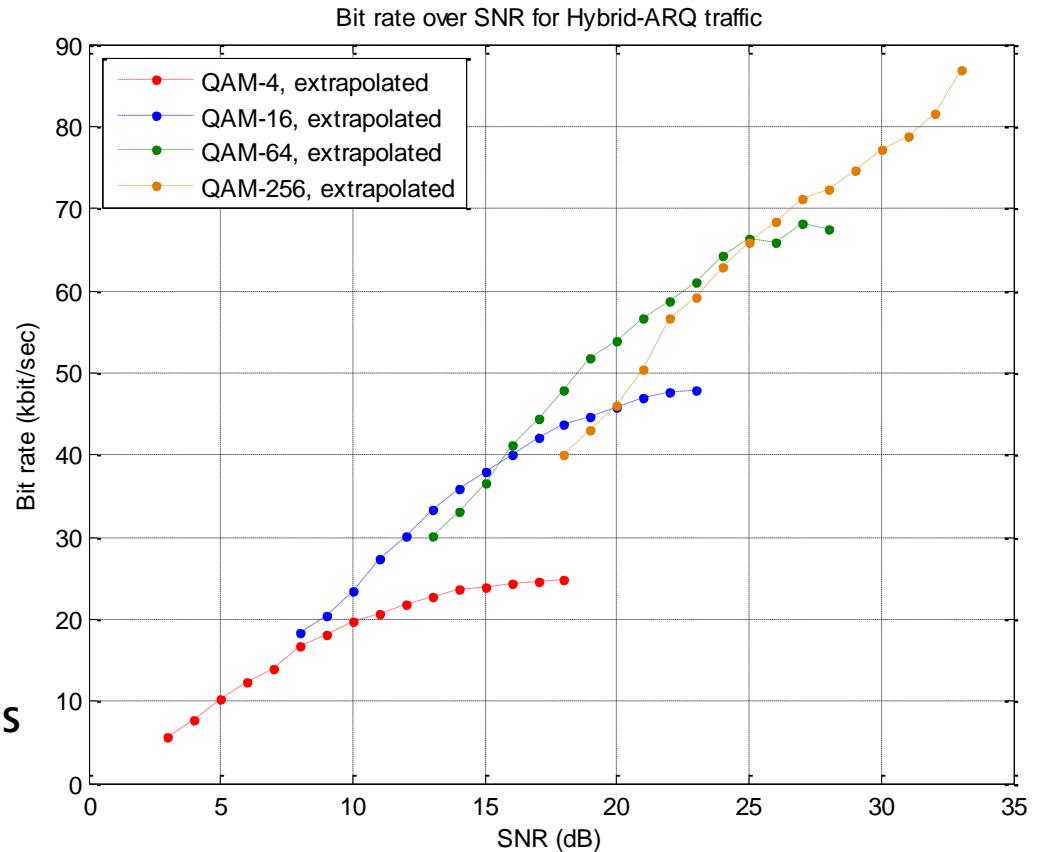
Performance evaluation on wired HF lab setup

■ Setup:

- CCIR POOR channel
- Bandwidth 24 kHz
- Extrapolated bitrate performance
- HARQ mode

■ Results:

- Automatic data rate adaption due to HARQ
- Data rates up to 80 kbps under poor channel conditions



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HDR-HF Project Conclusions

- A real-time very high data rate HF demonstrator prototype has been developed
- Several on-air measurement campaigns were organized to validate the developed system demonstrator
- Implementation of a robust and scalable OFDM waveform
- The waveform offers data rates up to 80 kbps in 24 kHz bandwidth under poor channel conditions
- HDR-HF demonstrated the feasibility of an IP-native solution for a very high data rate multimedia & data system in IPv6 over HF

Stimulus for future work and collaboration

- Study the adaptive choice of modulation and interleaving under varying channel conditions
- There is a need for automated link establishment and link maintenance
- Extend the waveform for both better and worse channel conditions for higher throughput and higher availability
- Extend the waveform and study the point-to-multipoint communication capabilities inside an HF radio network

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Thank you for your attention!

Questions welcome!

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