

Instantaneous channel access for 3GALE systems

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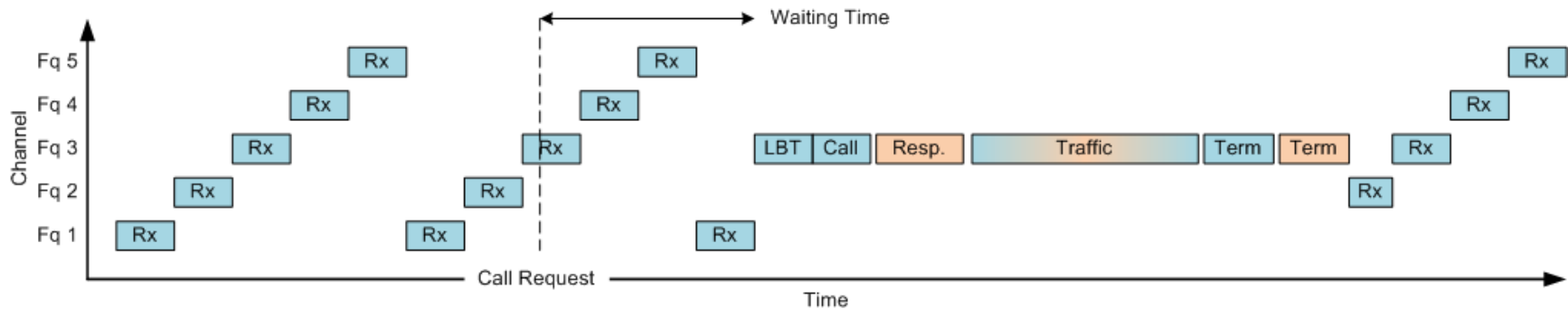
Background

- The HF house defines the HF Standards, among them the ALE standards
- Besides these there are the data link standards, L11, L22
- Currently for the Swedish Armed Forces there is a requirement to transfer time critical messages in a meshed network.
- The ALE standards are supporting a network with different propagation paths but have a long link establish time
- The datalink standards ensure fast message transfer in a reliable scheme through TDMA but only in a network with predictable and similar propagation paths
- The main argument for this proposal is to overcome the main drawbacks in the STANAG 4538 3GALE system
 - The potentially long link establish time
 - Risk of calling collisions in a network with heavy traffic load

Alternative methods

- Legacy fixed frequency operation.
 - High risk for collision during moderate to heavy traffic load
- Some proprietary ALE systems and AQC-ALE were able to link swiftly by using
 - Fast scanning
 - Few channels in scan group
- TDMA based systems. Mainly fixed frequency operation.
 - Designed for groundwave propagation networks.

STANAG 4538 FLSU



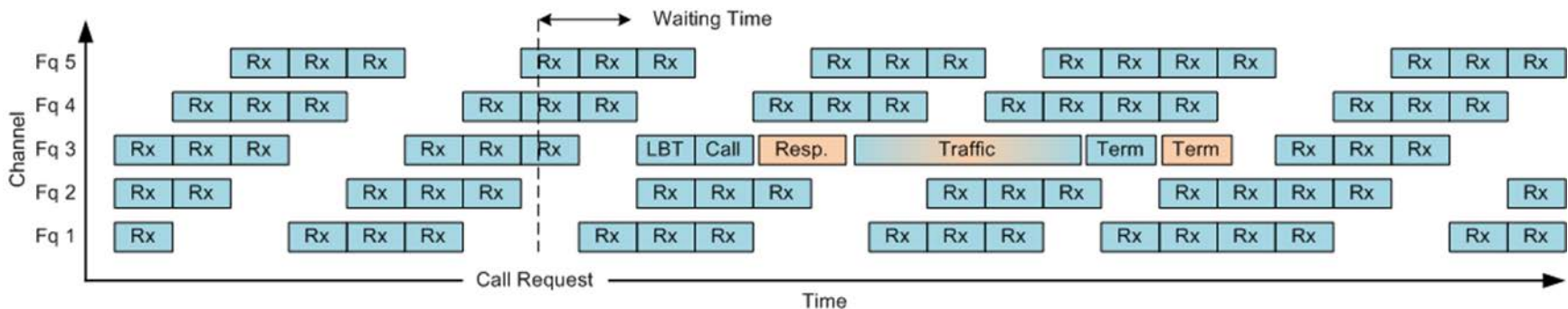
- STANAG 4538 uses synchronous scanning with 1.35 sec dwell period per channel
- Calling channel is selected among candidates within a Look-ahead window. The Look-ahead window size is determined by traffic type.
- A STANAG 4538 Fast Link Set-Up (FLSU) call have to wait until the to-be called station is on the selected calling channel

Technical Feasibility

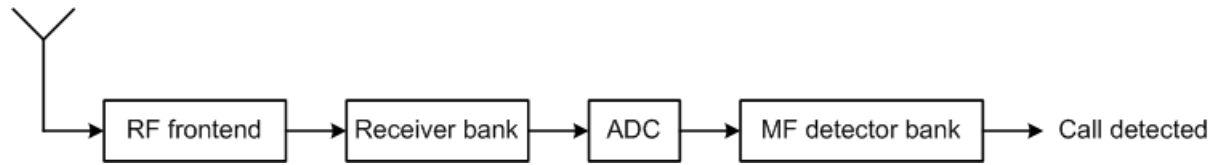
- Monitoring several channels simultaneously
- Only capable of detecting incoming calls
- Will reduce link establishment time
- Will substantially reduce the necessity of a look ahead window
- Moderate costs

Aim

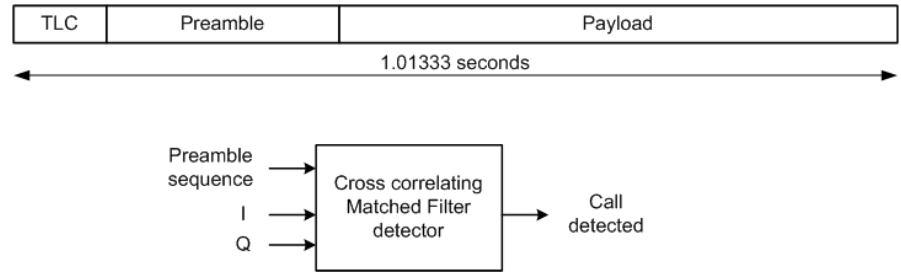
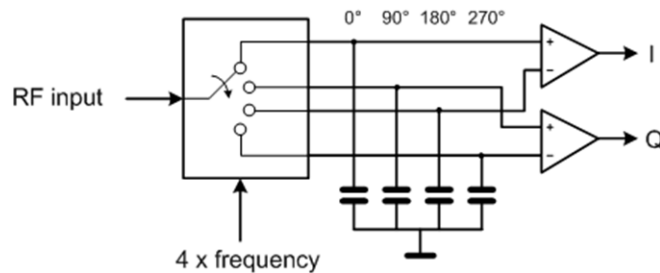
- Desirable to shorten the total link establishment time by reducing the waiting time
- Reduce waiting time by monitoring several channels in parallel and allow calls to be placed between such nodes at times of channel monitoring
- Backwards STANAG 4538 interoperability still ensured



Parallel receiver



Only able to detect S4538 BW5 signals



Taylor detector

- The receiver bank consists of direct down sampling receivers based on the Taylor detector principle
- Implemented by analog switch scanning at the rate of the desired RF frequency

Matched Filter detector

- The 576 PSK symbols long acquisition Preamble detect incoming S4538 BW5 calls
- The cross-correlating MF detector compares the input signal with the Preamble. Threshold determines sensitivity

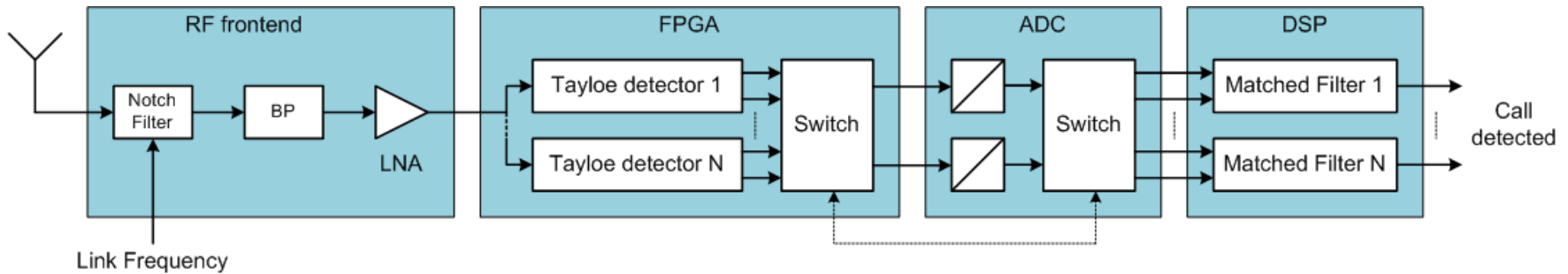
Software Defined Radio concepts



A multitude of different SDR units on the market
One typical example: Universal Software Radio Peripheral (USRP) from Ettus Research, US

- Xilinx Spartan 3A-DSP 3400 FPGA
- OMAP 3:
 - 800 MHz ARM
 - TI C64 DSP
- 12 bit 64 MS/s ADC
- 512 MB RAM + 4 GB Flash memory
- RF frontend modules available

Block diagram of parallel receiver



- The RF front end consists of
 - an adaptive RF notch filter controlled by the Tx signal on an active 3GALE link,
 - an HF bandpass filter and
 - a low-noise amplifier
- The Taylor detector array will probably be constructed by discrete circuits (e.g. 74HC4052) but in near time by an analog FPGA circuit
- The ADC operates on audio baseband and is thus not performance critical
- A DSP handles the cross-correlation MF detectors
- A microcontroller provides the overall control and communication with the regular 3GALE system

Final Remarks

- It seems like the concept with instantaneous channel access would be possible to realize with today's SDR technique
- Next step would be for FMV to find an industry partner to develop a prototype system which would integrate to our existing HF systems (HF2000 and/or Harris 5800H Manpack)
- An initial target for a prototype system would be to support a 3G ALE net with 10 parallel receiver channels