1.1 proof:

let us consider for continious signal. the

cross correlation $(x \star y)(n) = \int_{-\infty}^{\infty} x^*(m) \cdot y(m+n)\, dm$

~~Now in Fourier dom~~

Now applying fourier transform:

$$F\left[(x \star y)(n)\right] = \int_{-\infty}^{\infty} \left[\int_{-\infty}^{\infty} x^*(m)\, y(m+n)\, dm \right] e^{-i2\pi fn}\, dn$$

Multiplying and dividing R.H.S by $e^{-i2\pi fm}$

$$= \int_{-\infty}^{\infty} x^*(m)\, e^{-i2\pi fm}\, dm \int_{-\infty}^{\infty} y(m+n)\, e^{-i2\pi fn} \cdot e^{i2\pi fm}\, dn$$

$$= \int_{-\infty}^{\infty} x^*(m)\, e^{-i2\pi fm}\, dm \int_{-\infty}^{\infty} y(m+n)\, e^{-i2\pi f(n-m)}\, dn$$

let, $n - m = t$.

then,

$$F\left[x \star y\right](n) = \int_{-\infty}^{\infty} x^*(m)\, e^{-i2\pi fm}\, dm \int_{-\infty}^{\infty} y(m+n)\, e^{-i2\pi ft}\, dt.$$

$$= X^*[f]\, Y[f]$$ where $X^*[f]$ is the continious fourier transform of conjugate of $x(n)$.

So, As we know convolution properties hold for DFT if it holds for CFT, then,

$$F[x \star y](n) = \left[DFT^*\{x\} \cdot DFT\{y\}\right](n).$$

$$\therefore (x \star y)(n) = DFT^{-1}\left[DFT^*\{x\}\, DFT\{y\}\right](n)$$

[proved].

1.3

1.3

The time delay of arrival (TDOA) between the reference channel and any other channel for any given segment to estimate it as the delay that causes the cross-correlation between the two signals segments to be maximum. In order to improve robustness against reverberation to use the Generalized Cross Correlation with Phase Transform (GCC-PHAT).