$$\begin{pmatrix} F_1 \\ F_2 \\ F_3 \end{pmatrix}_i = \begin{pmatrix} x \\ y \\ z \end{pmatrix}_i - \lambda M \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_i - \begin{pmatrix} t_x \\ t_y \\ t_z \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

30-1

$$\frac{\partial F_{1i}}{\partial X_i} = 1 \quad \frac{\partial F_{1i}}{\partial Y_i} = 0 \quad \frac{\partial F_{1i}}{\partial Z_i} = 0$$

$$\frac{\partial F_{2i}}{\partial X_i} = 0 \quad \frac{\partial F_{2i}}{\partial Y_i} = 1 \quad \frac{\partial F_{2i}}{\partial Z_i} = 0$$

$$\frac{\partial F_{3i}}{\partial X_i} = 0 \quad \frac{\partial F_{3i}}{\partial Y_i} = 0 \quad \frac{\partial F_{3i}}{\partial Z_i} = 1$$

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$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} - \lambda M \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} - \begin{pmatrix} t_x \\ t_y \\ t_z \end{pmatrix}$$

Every expression evaluated at CURRENT value of approx

30-2

$$\frac{\partial F_{1i}}{\partial X_i} = -\lambda m_{11} \quad \frac{\partial F_{1i}}{\partial Y_i} = -\lambda m_{12} \quad \frac{\partial F_{1i}}{\partial Z_i} = -\lambda m_{13}$$

$$-\lambda m_{21} \quad -\lambda m_{22} \quad -\lambda m_{23}$$

$$-\lambda m_{31} \quad -\lambda m_{32} \quad -\lambda m_{33}$$

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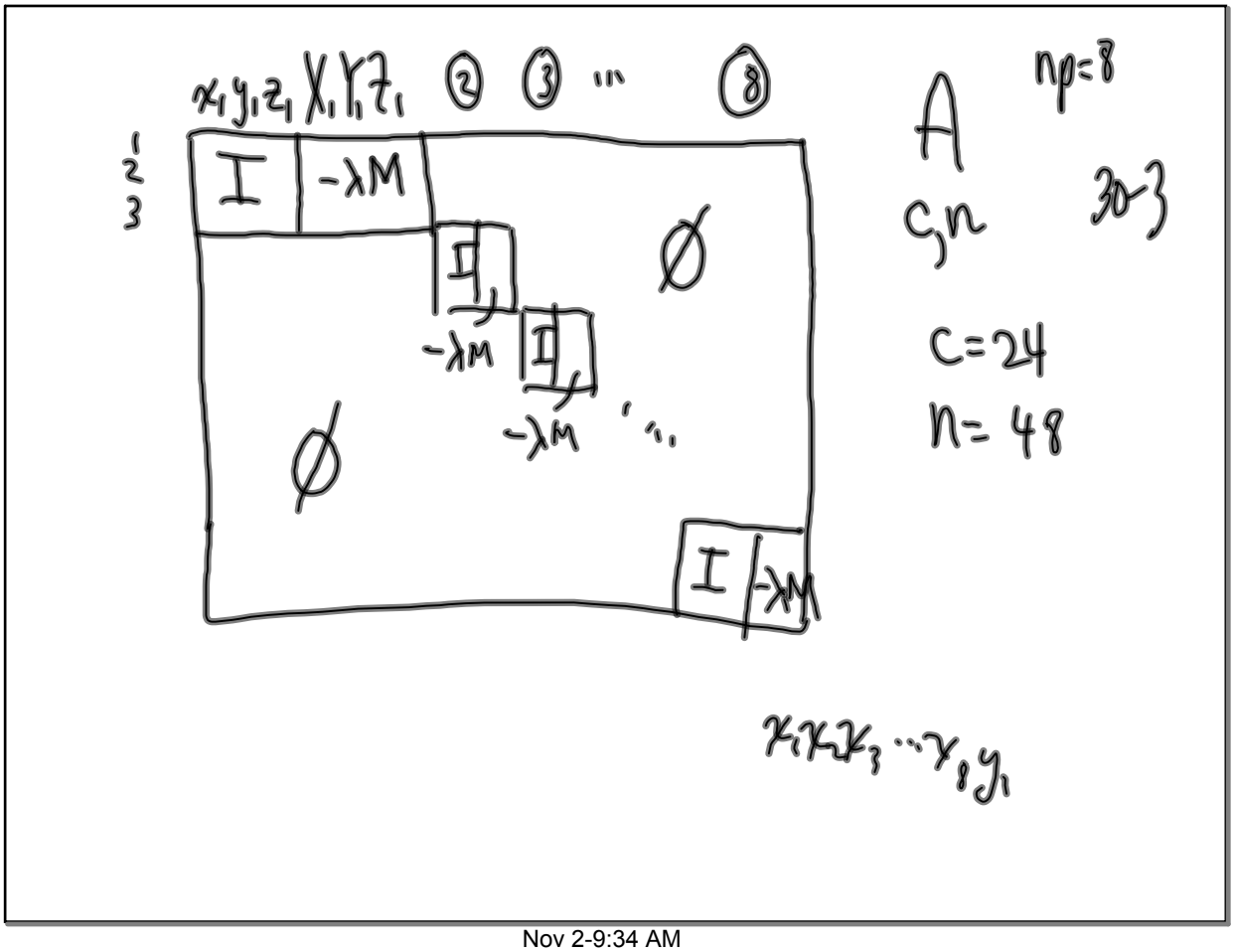

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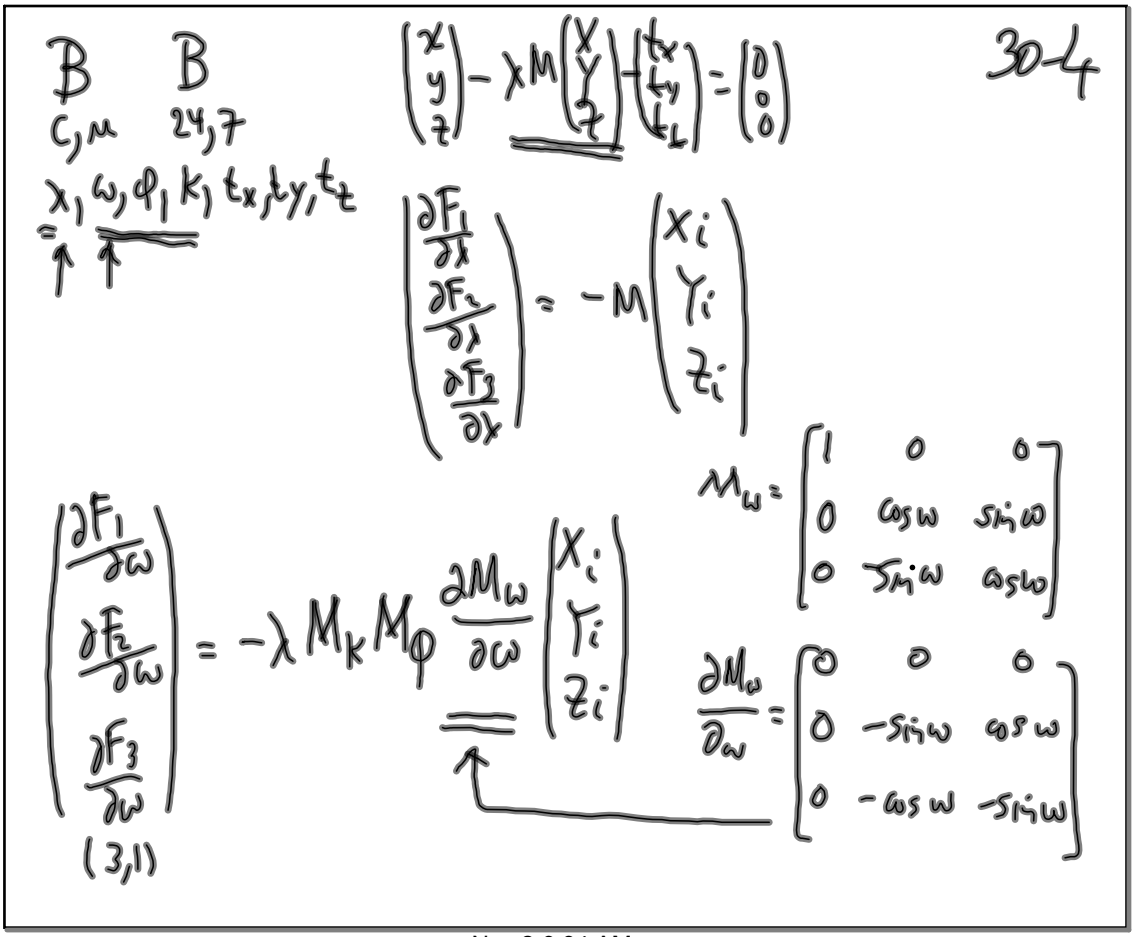

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$$\frac{\partial F}{\partial \varphi} = -\lambda M_k \frac{\partial M_\varphi}{\partial \varphi} M_\omega \begin{pmatrix} x_i \\ y_i \\ z_i \end{pmatrix}$$

(3,1)

$$M_\varphi = \begin{pmatrix} \cos\varphi & 0 & -\sin\varphi \\ 0 & 1 & 0 \\ \sin\varphi & 0 & \cos\varphi \end{pmatrix}$$

30-5

$$\frac{\partial M_\varphi}{\partial \varphi} = \begin{pmatrix} -\sin\varphi & 0 & -\cos\varphi \\ 0 & 0 & 0 \\ \cos\varphi & 0 & -\sin\varphi \end{pmatrix}$$

$$\frac{\partial F}{\partial k} = -\lambda \frac{\partial M_k}{\partial k} M_\varphi M_\omega \begin{pmatrix} x_i \\ y_i \\ z_i \end{pmatrix}$$

(3,1)

$$M_k = \begin{pmatrix} \cos k & \sin k & 0 \\ -\sin k & \cos k & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$\frac{\partial M_k}{\partial k} = \begin{pmatrix} -\sin k & \cos k & 0 \\ -\cos k & -\sin k & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

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shifts $\begin{pmatrix} x \\ y \\ z \end{pmatrix} - \lambda M \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} - \begin{pmatrix} t_x \\ t_y \\ t_z \end{pmatrix}$

30-6

$$\frac{\partial F}{\partial T} = -I$$

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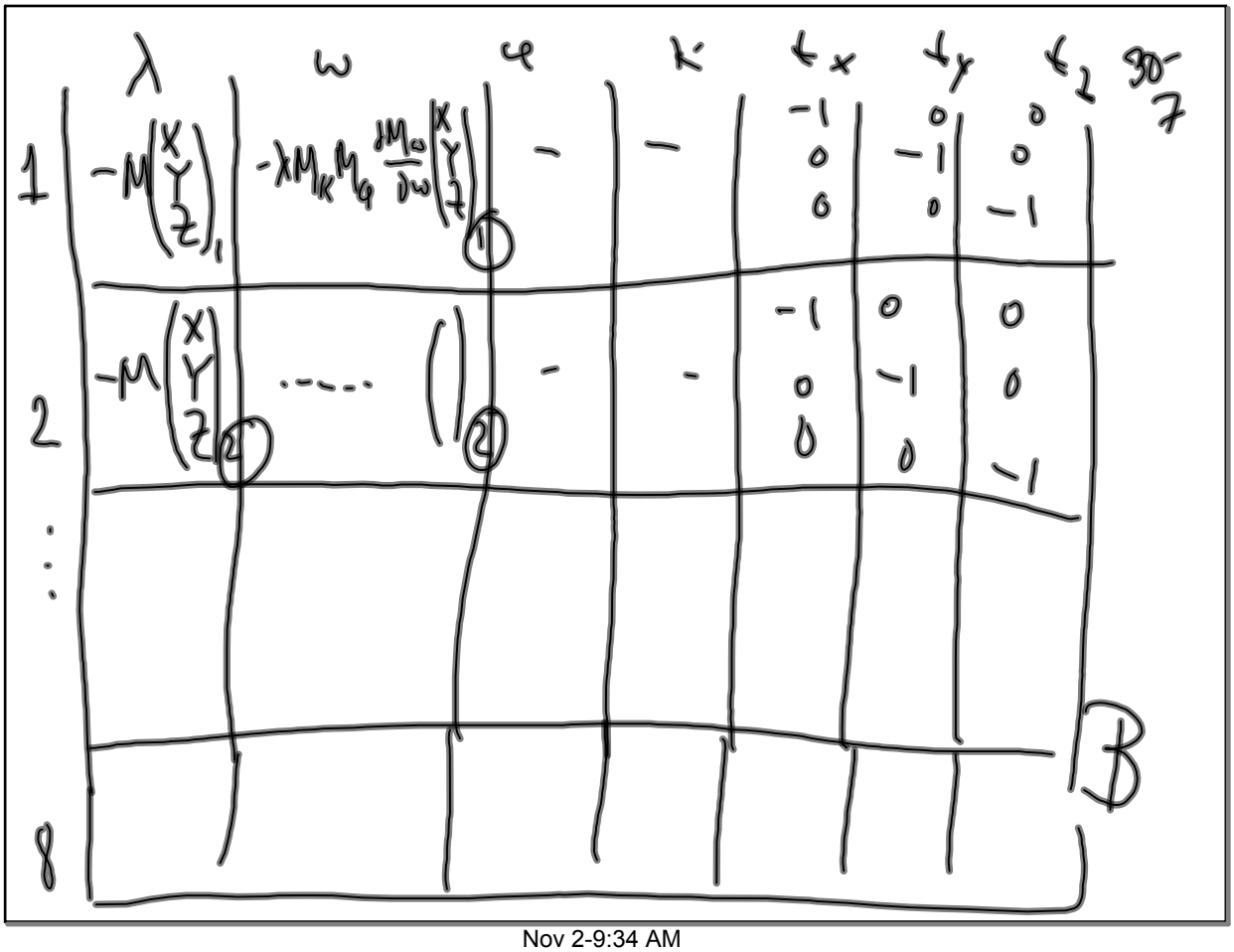

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Right Side Vector 30-8

$$f = -F^0 - A(\bar{l} - \bar{l}^0)$$

$\bar{l}$: current estimate; $\bar{l}^0$: original

$$f_{\text{point } i} = -F^0_{\text{Point } i} - A_i \times \begin{bmatrix} x_1 - x_1^0 \\ y_1 - y_1^0 \\ z_1 - z_1^0 \\ X_1 - X_1^0 \\ Y_1 - Y_1^0 \\ Z_1 - Z_1^0 \end{bmatrix}$$

(3,1) 3,1 3,6 6,1

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full NE, or elimination solution 30-9

$Q_e = AQA^T$ $\quad v = QA^T k$

$Q = W^{-1}$

$W_e = Q_e^{-1}$

$N = B^T W_e B$ $\quad X = X + \Delta$

$t = B^T W_e f$ $\quad l^0 = l + v$

$\Delta = N^{-1} t$

$k = W_e(f - B\Delta)$ $\quad \Delta l = l^0_{new} - l^0_{old}$

new ↑ origin ↑ just computed

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2 way ranging $t_2 - t_1 = \Delta t$ same clock 30-10

1 way ranging $t_2 - t_1 = \Delta t$ different clocks

Basic clock 10.23 MHz

$154 \times 10.23\ MHz = 1575.42\ MHz$ L1

$120 \times 10.23\ MHz = 1227.60\ MHz$ L2

L-Band

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