# Multiple Hypothesis Tracking for a Non-Contiguous Battlespace

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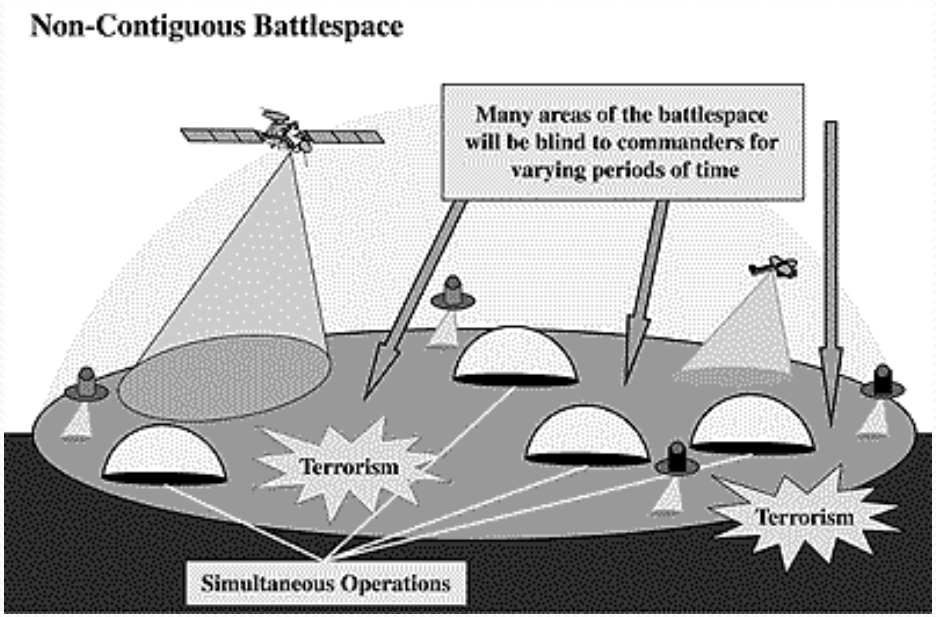
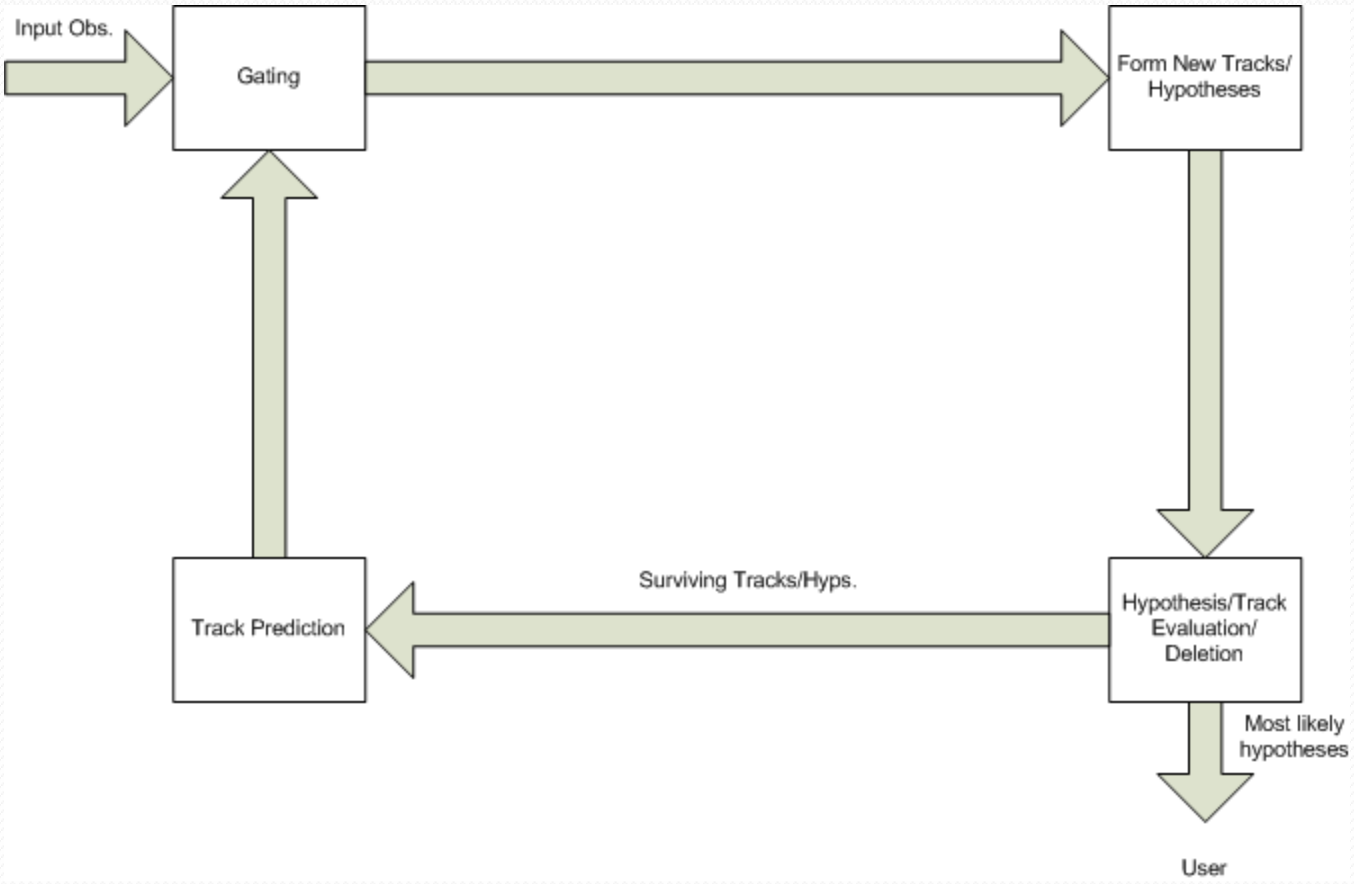
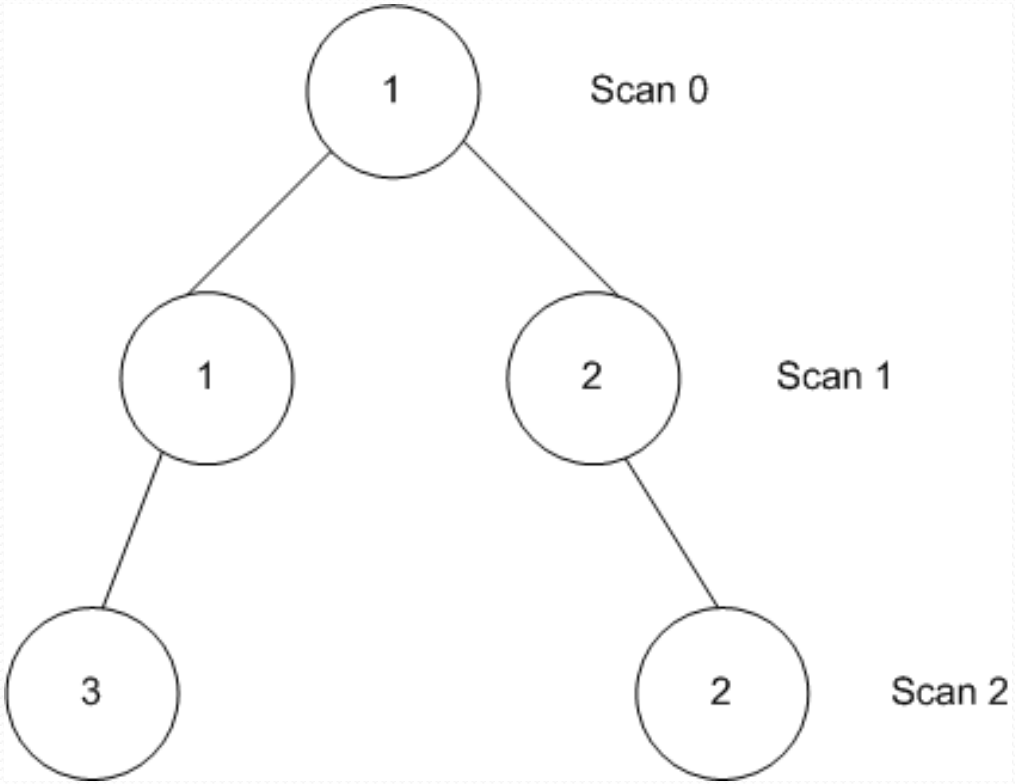
# Background

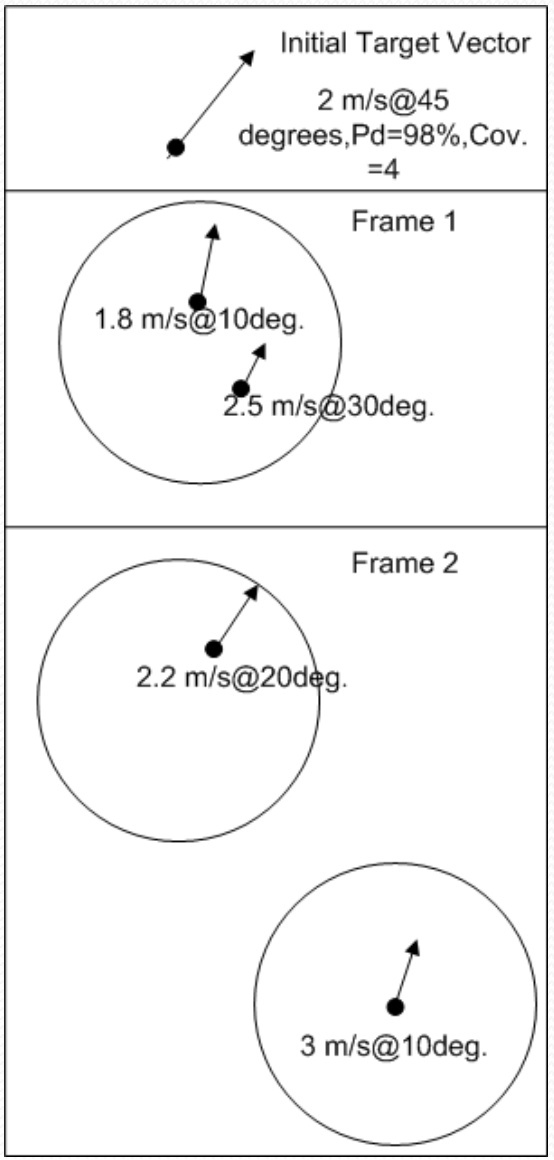

Non-Contiguous Battlespace
Many areas of the battlespace will be blind to commanders for varying periods of time
Terrorism
Terrorism
Simultaneous Operations

# Multiple Hypothesis Tracking



# Example


1
Scan 0
1
2
Scan 1
3
2
Scan 2


Initial Target Vector
2 m/s@45 degrees,Pd=98%,Cov. =4
Frame 1
1.8 m/s@10deg.
2.5 m/s@30deg.
Frame 2
2.2 m/s@20deg.
3 m/s@10deg.

# Gating

$$w_{l,r}^{n}(t) = \frac{\pi_l \mathcal{N}\left\{\mathbf{z}_r(t); \mathbf{H}_l(t)\mathbf{x}_l^n(t), \mathbf{R}_l(t)\right\}}{\sum_{p=1}^{M}\left[\pi_p \mathcal{N}\left\{\mathbf{z}_r(t); \mathbf{H}_p(t)\mathbf{x}_p^n(t), \mathbf{R}_p(t)\right\}\right]} \quad (5)$$

where $\mathcal{N}$ refers to a multivariate Gaussian *pdf* with the specified mean and covariance.

$$\tilde{\mathbf{z}}_s(t) \equiv \frac{\sum_{r=1}^{n_t} w_{sr}^{n}(t)\mathbf{z}_r(t)}{\sum_{r=1}^{n_t} w_{sr}^{n}(t)}$$

$$\tilde{\mathbf{R}}_s(t) \equiv \frac{\mathbf{R}_s(t)}{\sum_{r=1}^{n_t} w_{sr}^{n}(t)}$$

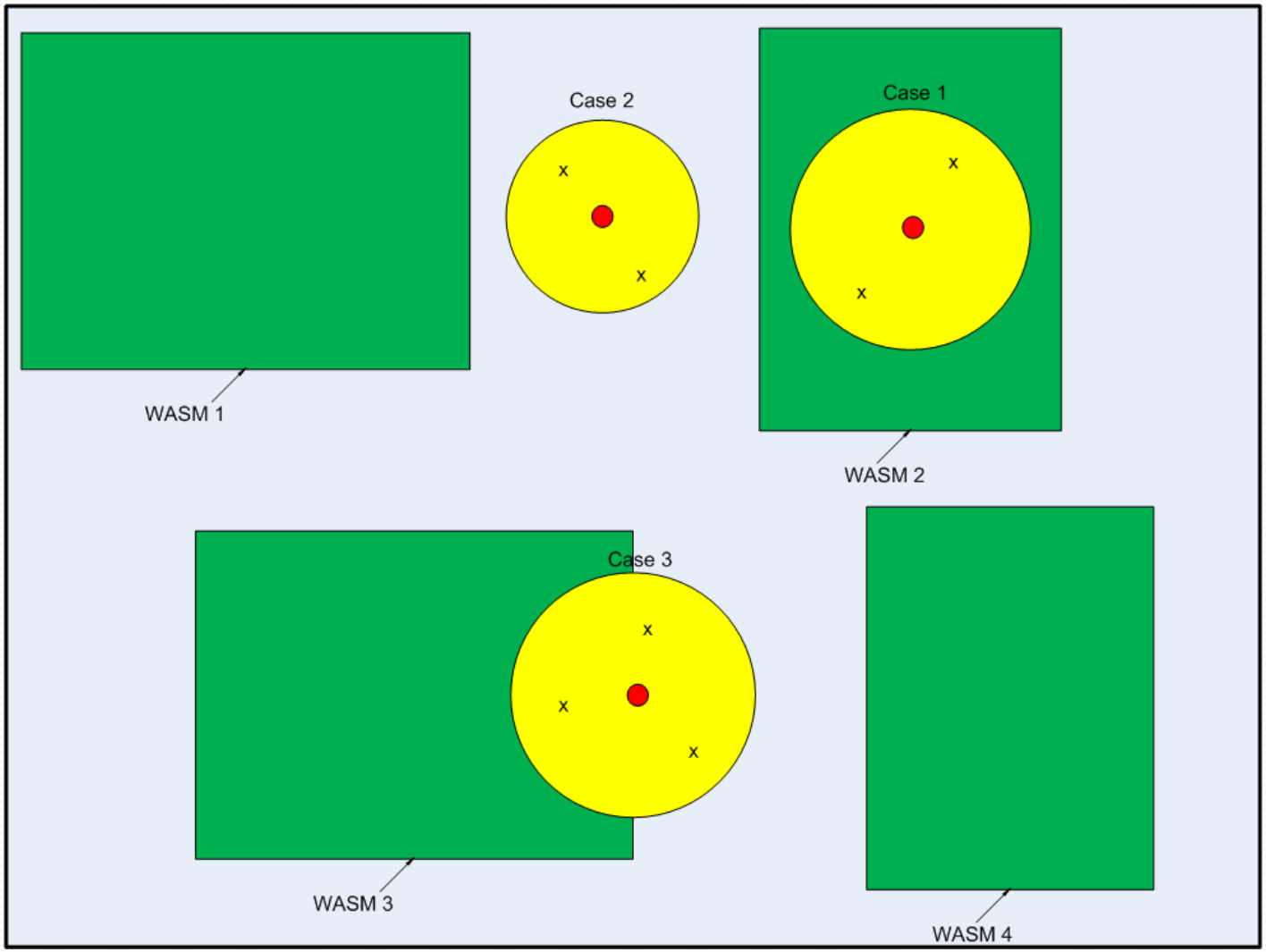
# Eliminating Branches

- Likelihood Ratio $LR = \frac{p(D|H_1)P_0(H_1)}{p(D|H_0)P_0(H_0)} \triangleq \frac{P_T}{P_F}$
- Log likelihood ratio $LLR = ln[P_T|P_F]$
- Probability of a True Target $P_T = e^{LLR}/[1 + e^{LLR}]$
- Track Score at scan k

$$L(k) = L(k-1) + \Delta L(k)$$

$$\Delta L(k) = \begin{cases} \ln\left(1 - \widehat{P_D}\right); no\ update\ on\ scan\ k \\ \Delta L_u(k); track\ update\ on\ scan\ k \end{cases}$$

# Possible Cases



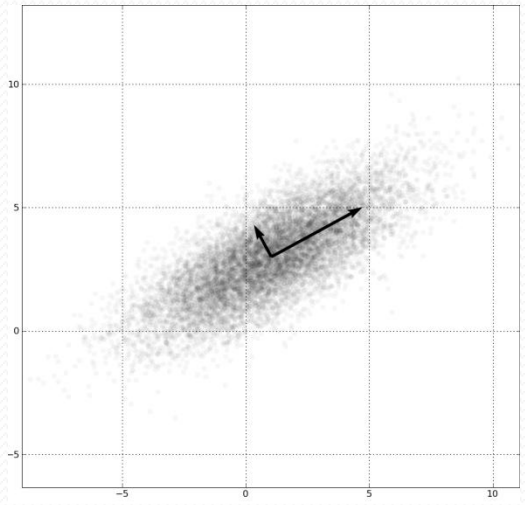
# Looking at the Different Cases

- Case 1 already can be solved
- Case 3 Requires a combination of Case 1 and Case 2
- Case 2 is Top Priority

# Assumptions

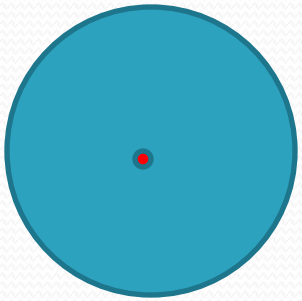
- WASMs update simultaneously
- WASMs are stationary
- 30 minutes of life
- Ground targets(2-D only: Tanks, SUV, Turrets, etc.)

# Increasing Uncertainty

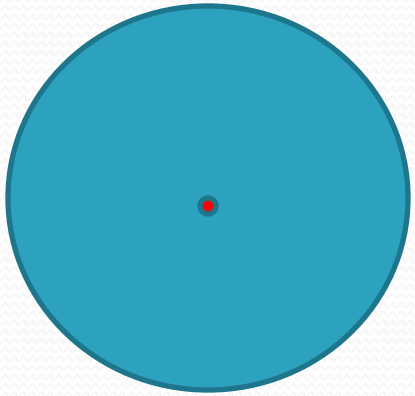



Multivariate Gaussian Distribution

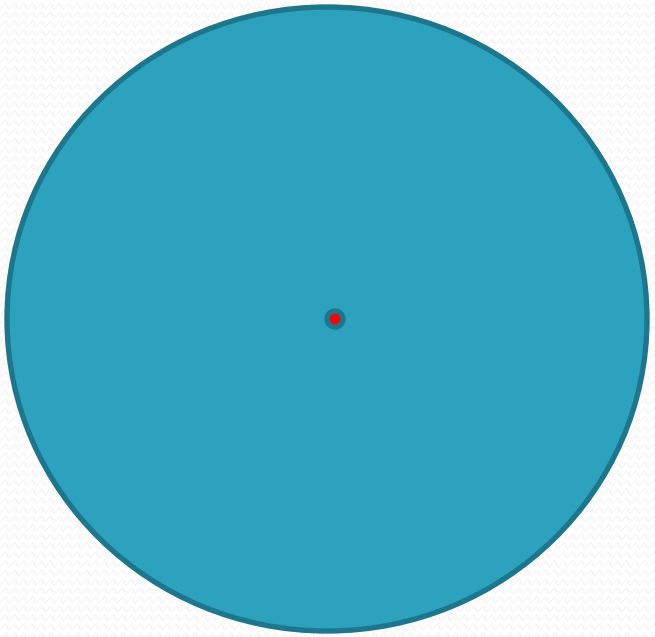
Frame 1



Frame 2



Frame 3



# Remaining Work

- Develop a Threshold for Uncertainty
- Develop Test Cases and Perform Simulation
- Summarize Findings