Corps of Engineers, Kansas City Office – Flood Control

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RiverWare Model

- Test model of a portion of the Kansas River system
  - 6-hour timestep, operational model
- Inflow forecasting, surcharge operations, and flood control
  - Flood control based on phase balancing
- Need for RiverWare model
  - No previous models for operations/planning
  - Algorithms designed from operations manuals and from the operating procedures used by the operators

Surcharge Release

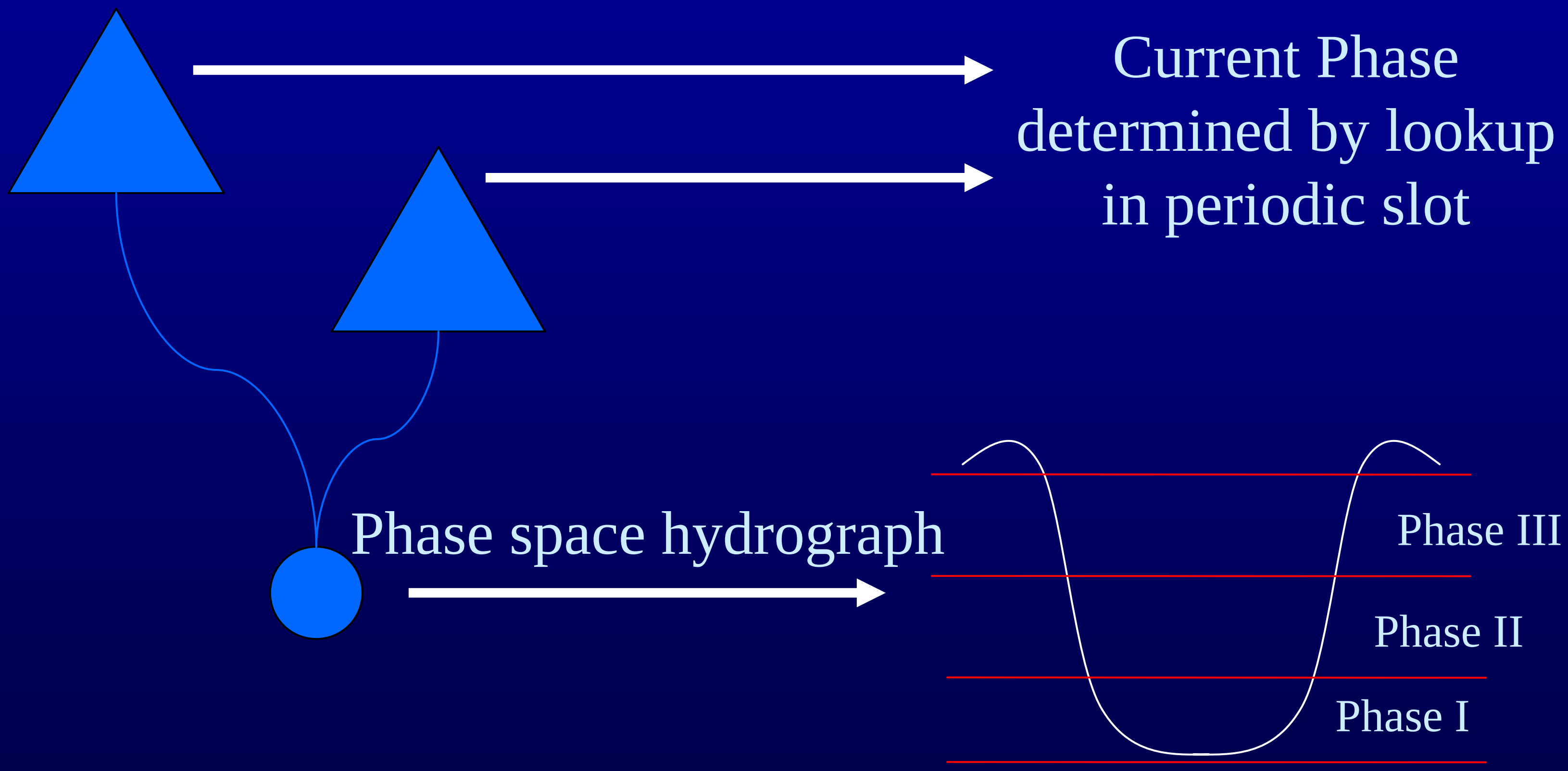
- Three different surcharge methods used:
- Induced Surcharge Curve
  - Series of curves defining the surcharge release based on forecasted inflow and pool elevation
  - Maintain gate opening as pool elevation falls back to top of flood pool
- Specified Surcharge Release
  - Release specified amount when elevation enters surcharge pool
  - Release maximum when critical pool elevation is exceeded
- Pass Inflows
  - Pass inflows until max release is reached, maintain until elevation falls back to flood pool

Phase Balancing (KC-COE flood control)

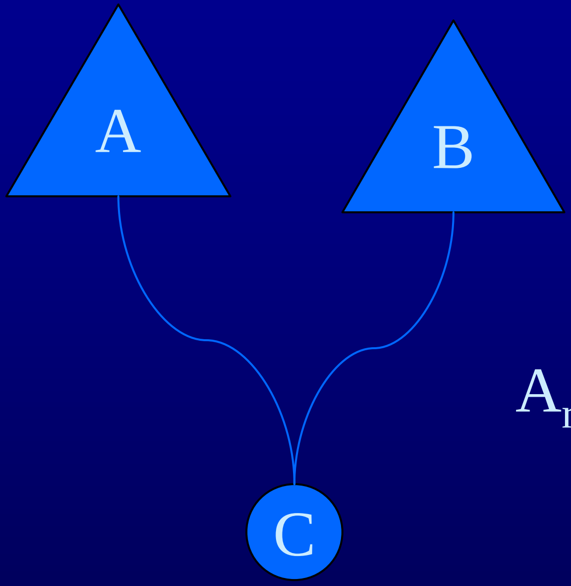
- Reservoirs are balanced by integral phase.
- Higher phase reservoirs have higher release priority
- Releases from equal phase reservoirs are determined by a reservoir weighting factor

W = Coefficient x PercentageOfOccupiedFloodPool

Phase


Current Phase
determined by lookup
in periodic slot
Phase space hydrograph
Phase III
Phase II
Phase I

Simple Case (no routing)



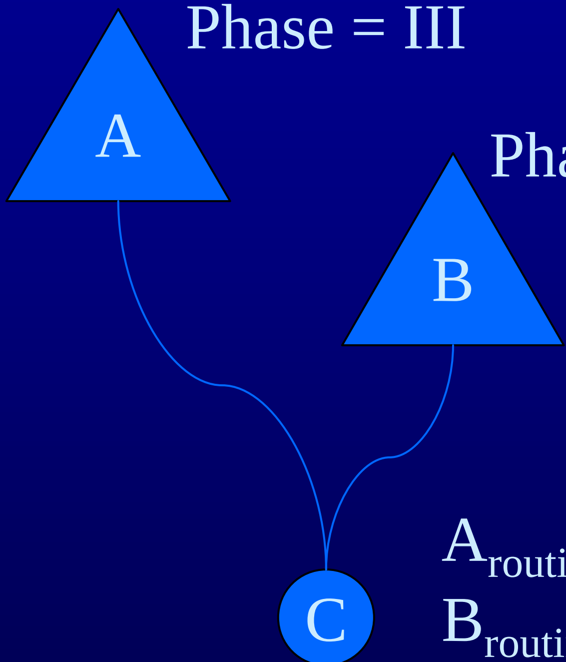
$$A_{release}(t) = \frac{A_{weight}(t\text{-}1)}{A_{weight}(t\text{-}1) + B_{weight}(t\text{-}1)} * C_{phaseSpace}$$

$$B_{release}(t) = \frac{B_{weight}(t\text{-}1)}{B_{weight}(t\text{-}1) + A_{weight}(t\text{-}1)} * C_{phaseSpace}$$

Flood Control Release Example

Phase = III

Phase = III

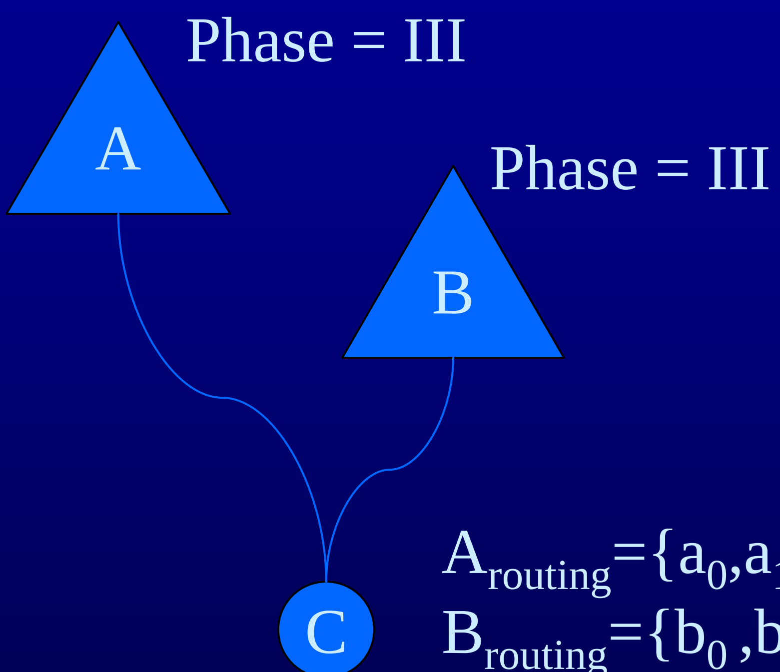


$A_{routing}=\{a_0,a_1,\ldots\}$

$B_{routing}=\{b_0\ ,b_1,\ldots\}$

$$Arelease(t) = \min(C_{allocation}(A,t,0)/a_0,\ \ C_{allocation}(A,t,1)/a_1,\ \ \ldots)$$

Flood Control Release Example (cont.)



$A_{routing}=\{a_0,a_1,\ldots\}$

$B_{routing}=\{b_0\,,b_1,\ldots\}$

$$C_{allocation}(A,t,0) = \frac{A_{weight}(t\text{-}1)*a0}{A_{weight}(t\text{-}1)*a_0 + A_{weight}(t\text{-}1)*a_1 + \ldots + B_{weight}(t\text{-}1)*b_0 + B_{weight}(t\text{-}1)*b_1 + \ldots} * C_{phaseSpace}(t+0)$$

General Case with routing

R_{weight} = Reservoir Weight

$R_{coefficient}$ = Routing coefficent to control point

$C_{allocation}$ = Phase space allocation at control point

C_{total} = Total available phase space at control point

$$C_{allocation} = \frac{R_{weight} * R_{coefficient}}{\sum_{\forall \alpha, \alpha \in \text{Same Phase Reservoirs}} \left[\alpha_{weight} * \sum_{\text{unknown releases}} \alpha_{coefficient} \right]} * C_{total}$$

$$R_{release} = \min(C_{allocation} / R_{coefficient}) \quad \forall C, C \in \text{control points}$$